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TITLE OF THESIS/*TITRE DE LA THÈSE* An Econometric Analysis of the Tariff in Canadian-American Cattle Trade

UNIVERSITY/*UNIVERSITÉ* Alberta

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* M.Sc.

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* 1975

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THE UNIVERSITY OF ALBERTA

AN ECONOMETRIC ANALYSIS OF THE TARIFF IN CANADIAN-AMERICAN CATTLE TRADE

by

©

ALFRED LAWRENCE BIRCH

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

EDMONTON, ALBERTA

SPRING, 1975

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read and recommend to the Faculty of Graduate Studies for acceptance a thesis entitled "An Econometric Analysis of the Tariff in Canadian-American Cattle Trade," submitted by Alfred L. Birch in partial fulfilment of the requirements for the degree of Master of Science.

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ABSTRACT

The movement of live cattle across the Canadian-American border has been of great importance to the cattle industries of both countries. Such trade has provided an extended market for cattle producers and has introduced foreign competition into domestic markets. Due to the occassionally disruptive effect of such imports, trade restrictions have been instituted to guard domestic producers and to increase the leeway for domestic policies in their support. The tariff has been an important policy instrument in the regulation of agricultural trade between Canada and the United States. Tariff and trade policy applying to movements of live cattle between the two countries underwent a number of changes in response to changing market conditions during the period of 1970 to 1973. Therefore, the researcher was afforded the opportunity to evaluate the dynamic nature of the tariff in controlling cattle trade during this period.

In that the tariff influences trade through the medium of price, its effect on trade volume may be equated with that of the price spread or differential. Canadian imports of American slaughter cattle displayed a price-cum-tariff elasticity of one, while American imports of Canadian feeder cattle displayed an inelastic response to the price-cum-

tariff. Bilateral and equal tariff adjustments would therefore be expected to have greater influence on the flow of cattle into Canada than into the U.S.A. In that the tariff does not vary with the price spread, as would a variable levy, it reduces the profitability of trade by a constant amount, and is thus a "regressive" instrument of trade control.

The present study examines a number of regression models in analysing Canadian-American cattle trade. Emphasis is placed on evaluation of the methodology as well as on the trade policy conclusions reached.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made of the assistance received in completing this thesis. To Mr. Jim Copeland and Mr. Clare Shier I owe my ability in the use of the computer. Miss Evelyn Shapka gave me valuable assistance in polishing the style and format of the draft. The members of my committee, Dr. Peter Apedaile, Dr. Thomas Powrie and Dr. Joseph Rosario, made suggestions which were appreciated and are reflected in the content of what I have written. To Dr. Jim Weibe I owe sincere thanks for allowing and encouraging me to complete this project while holding a full time job under him. To my supervisor and friend, Dr. Joseph Richter, I owe my sincere gratitude. His heuristic and insightful approach to my education must take credit for much of what I know and enjoy in my field of study. And finally, my deepest gratitude to my wife, Robbie, who went through it all with me.

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CHAPTER I

INTRODUCTION

The Context

The agricultural sector in a modern, industrialized economy is faced with a variety of economic problems. Two of the most basic are the low level of incomes in the long run, and in the short run, their instability. The income problem has typically been linked with the price of agricultural commodities; when prices are low, incomes have been correspondingly low. This connection was so common and logical, in fact, that "the" basic problem of agriculture was often referred to as one of low and unstable prices. The level of agricultural commodity prices is determined by the short run supply of and demand for agricultural products, both of which are inelastic. Short run supply inelasticity is a result of the relative immobility of agricultural input resources, while long run demand inelasticity is a result of basic consumer tastes. In a market in which both supply and demand are inelastic, relatively small shifts in either cause large fluctuations in price, resulting in price and income instability. The impact of improved technology on agricultural production is to increase output per unit of input but to leave unaffected the total stock of inputs. The resulting excess capacity has been the fundamental cause of chronically low prices and incomes.

In recent years the agricultural scene has come to be characterised by rapidly rising product prices which have, in many cases, been the leaders in the general economic price inflation. The fact that farm incomes have not risen commensurately is due to the fact that incomes are dependent upon the cost-price spread rather than upon prices alone. While agricultural commodity prices have risen dramatically in the recent past, they have gained little on the price of agricultural inputs. In an industry which has undergone enormous modernization and adoption of new technology in the past fifty years, purchased inputs are of great significance and their general price level has been demonstrated to be of equal importance to commodity prices in the determination of the incomes of farmers.

Ideally, a long run solution to the problem of low incomes in agriculture would involve the movement of labour to industries with higher wages. It is evident, however, that agricultural labour is not perfectly mobile and, in fact, does not respond particularly well to efforts to direct it to more remunerative locations. The course taken by governments has therefore typically been to pursue an indirect solution to the income problem by concentrating on agricultural commodity prices. Supply management, perhaps the most widely employed solution, has involved attempts to actually restrict production, as in the case of the American Soil Bank programme, or attempts to control the marketing of commodities, an important goal in Canadian agricultural policy and legislation. The instability of agricultural commodity prices has been attacked through various price stabilization schemes. The Canadian Agricultural Stabilization Board has been involved in commodity price stabilization through the purchase of selected products and the distribution of deficiency payments to producers of other products. A third method by which governments have sought to improve commodity prices is the stimulation of demand such as through the concessional foreign sales of agricultural commodities under the American P.L. 480.

A consequence of government intervention in the production or marketing of agricultural commodities for the purpose of supporting or stabilizing prices and incomes is the need for some type of regulation of international trade. Distortions in the domestic market for agricultural products will normally, and almost inevitably, lead to some type of distortion in the international market. The connection can be clearly seen in the case of supply management programmes designed to support commodity prices. By definition, the marketed supply of the particular commodities must be limited, or at least "managed". This necessarily involves a similar management of imports. Increased gross returns to domestic farmers will result from the restriction of imports since this will boost the domestic price and avoid or reduce the necessity of cutting back on domestic production. If domestic production does have to be forcibly curtailed, there is certainly no desire to see the benefits of increased price going to competitive imports. These conclusions will apply whether the particular supply management programme is one of curtailed production or orderly marketing. Price stabilization will similarly be hampered if the domestic market is exposed to the vagaries of international supply and demand. The other approach to commodity price support, that of stimulating demand, often results in a different form of trade distortion — export subsidization. It may be seen, therefore, that the commodity price approach to the agricultural income problem is particularly prone to result in trade distortion policies. Whether or not there is open limitation of imports or subsidization of exports, competition in the domestic market will be limited by government support of domestic agricultural producers, thus putting imports at a disadvantage.

The instruments availible for the regulation of trade are numerous. Their classification normally begins with a distinction between tariffs and non-tariff barriers (NTBs). Tariffs are duties charged on imported goods and in Canada are under the jurisdiction of the federal Department of Finance. Tariffs may be levied as a specific charge per unit of the imported product or may be a specified percentage of the value of the import, in which case they are termed "ad valorem" tariffs, or they may be a combination of the two. Conversions may be made from one form of expression of a tariff rate to the other. To provide a basis of comparison between tariffs, specific rates of duty are often expressed in their "ad valorem equivalent".

The Canadian Customs Tariff, the catalogue of all rates of duty, lists major headings under which import duties are levied. Average tariff rates are the lowest under the British Preferential heading, slightly higher under the Most Favoured Nation heading, and highest under the General Tariff heading. Many items bear the same tariff rate under the British Preferential and Most Favoured Nation headings. Canada and the United States both afford Most Favoured Nation status to each other.

All trade restrictions, and in fact all trade distorting policies other than tariffs, fall under the heading of non-tariff barriers. While such an inclusive definition covers an extremely wide range of policy instruments, the most important NTBs are limited in number. Canadian-American agricultural trade is subject to quotas, including seasonal quotas and tariff-quota combinations, licensing requirements, health regulations, various customs classification procedures, and straightforward embargoes. These NTBs often appear to constitute a more serious or effective restriction on international trade than do tariffs. The importance of tariffs and NTBs to Canada is related to the importance of international trade to the Canadian economy.

Canadian agricultural trade is an important part of the agricultural sector and the Canadian economy in general. Agricultural exports have normally constituted about one third of farm cash receipts in Canada, as compared with 15 percent in the United States. Therefore, while the absolute volume of agricultural exports from the U.S. is larger, in relative terms such exports are more important in Canada. Exports of agricultural products have typically represented about 20 percent of total Canadian commodity exports, though in recent years this has varied with the size of wheat sales. Wheat itself makes up over 50 percent of the exports of Canadian farm products, with coarse grains and oilseeds also being important. Agricultural imports, on the other hand, have fluctuated between about 10 and 15 percent of total Canadian imports and have been composed largely of commodities not produced in Canada. It can be seen that the Canadian economy as a whole, and the agricultural sector in particular are dependent on international trade to maintain the present level of income and to provide much of the impetus for further growth.

Countries such as Canada who depend rather heavily on their export ability soon realize that efforts to raise the level of exports must be accompanied by a willingness to increase imports. Canadian advances, for example, on the export front must be paid for by concessions in the domestic market since those countries accepting Canadian exports require assurance that their exports will, in turn, be allowed access to our market. This is, in effect, a trading of voluntary restrictions on national sovereignty -- both trading partners willingly restricting the freedom of their commercial policy in order to obtain export benefits. The nature of this decision is not an "either/or" choice, but a whole continuum of options. Countries must decide, at least implicitly, how they will balance the benefits from increased exports against the costs of increased imports. It should be noted that while unilateral removal of import restrictions is possible, countries normally desire reciprocal liberalization. Freer imports may bring the benefits of more efficient foreign production and therefore lower prices, but the long run economic benefit from reciprocal liberalization will likely be greater since the stimulus to export industries will help to offset any depressing effect of tariff or other barrier reduction on import competing industries.

Canada has become well aware of these policy considerations through its experience in international affairs and negotiations. In the area of agricultural trade policy we have held an often stated, though not unqualified, policy of free trade. This is normally considered to be to the advantage of the majority of agricultural producers as well as to the consumer. While expanded export markets are naturally attractive to producers, their attitude toward import competition is more varied. Since Canada does not have comparative advantage in all agricultural products, and since it faces what may appear as unfair competition in others, there is pressure to maintain protection for those parts of the agricultural industry which would succumb to foreign competition.

Objectives and Organization of the Study

The primary objective of the present study is to investigate the tariff as a regulatory policy instrument in Canadian-American agricultural trade. While it is true that many non-tariff barriers are more effective than tariffs in controlling international agricultural trade, it is also true that there are definite advantages in examining tariffs. They are, first of all, the most widely used trade regulatory instruments in international commerce. Tariffs are applied to more traded goods than is any single NTB.[1] This means that the results of an analysis of the tariff as an instrument of commercial policy would be more widely applicable to the whole range of internationally traded commodities than would the analysis of any other trade regulatory instrument. A second advantage of choosing the tariff as the object of study is that it is probably the simplest commercial policy instrument with which to deal. Its operation is directly involved with the price system and the analysis of the tariff is therefore compatible with the main body of economic analysis. Tariff analysis is able to draw on a large and established body of economic theory and econometric techniques.

This study's investigation of the tariff as a regulatory policy instrument is primarily a statistical exercise. A specific objective of the study is to apply statistical analysis to data on Canadian-American trade in a limited number of agricultural products to estimate the parameters of the tariff's effect on such trade. It was believed that while valuable non-quantitative studies had been done in the area of tariff policy, there was a lack of econometric analysis of trade data leading to conclusions on the topics of commercial policy and trade regulation. Such an analysis is therefore attempted in the present study. The approach taken in this analysis is to estimate demand functions for imports of the two agricultural products selected and from these functions to derive a "tariff elasticity of demand for imports". Such an elasticity value is treated as an indication of the effect of the tariff on the volume of imports.

---

[1] David Robertson, International Trade Policy, (London:Macmillan Press, 1972), p. 16.

In the present study the theory of international trade regulation is briefly reviewed to provide a setting in which the analytical methodology may be appreciated. A second reason for the inclusion of such a theoretical review is to bring together points which may have a bearing on the conclusions drawn from the statistical analysis. It is believed that such statistically based conclusions ought to be tested and validated by comparison with relevant economic theory. Statistical significance is not sufficient to establish conclusive demonstration.

Drawing from the statistical analysis of Canadian-American trade in two agricultural products, the present study seeks to present conclusions on the role and effectiveness of the tariff as a regulatory policy instrument. An attempt is made to comment on Canadian tariff policy in the light of the present study's analytical results and its review of tariff theory.

Chapter II constitutes a review of the economic theory of tariffs and their role in the regulation of international trade. Chapter III introduces the study's econometric analysis. Topics of discussion include the objective of econometric analysis, a description of the problem and of the methodology employed in the analysis and a review of studies which influenced the selection of this methodology. Descriptions of the data used in the analysis and of the market characteristics for the two commodities dealt with are also included. Chapter IV is a detailed description of the results of the statistical analysis. It also includes a brief discussion of some of these results. Chapter V presents the study's overall conclusions and comments on trade and tariff poicy. It presents, as well, an evaluation of the degree to which the study has met its originally stated objectives.

CHAPTER II

REVIEW OF TARIFF THEORY

Introduction

The objective of this chapter is to give a brief examination of the theory of tariffs and trade restrictions. Before proceeding with such an examination, however, the reasons for trade itself must be established.

The question of why trade occurs was examined by David Ricardo[1] and other classical economists. The explanation which they presented was based on the labour theory of value. This theory essentially stated that the value of goods is tied to the amount of labour which they embody. The classical explanation of trade was thus based on the principle of comparative advantage, while being stated in terms of labour-based values. The labour theory of value has subsequently been rejected as invalid since the labour value embodied in a commodity is an inadequate measurement of its total value. This is not to say, however, that the wage component of the cost of production is unimportant, but simply that goods are not produced by labour alone, but by various combinations of all the factors of production: land, labour and capital.

---

[1] David Ricardo, Principles of Political Economy and Taxation, ed. E.C.K. Gonner (London: G. Bell & Sons, 1919).

The labour theory of value may be discarded, though, without destroying the principle of comparative advantage. The principle is valid when stated in terms of opportunity costs. The basic criterion for trade is that the country must get a higher price for its specialty, or pay a lower price for the product in which it is relatively not as productive, with trade than in the absence of trade.

The next logical question in examining the reasons for trade is: What causes differences in comparative costs? Bertil Ohlin,[1] working from the insights of his teacher, Eli Heckscher, posed an explanation based on the factors of production. Different goods, he stated, require different factor inputs and different countries have different factor endowments. Comparative cost will therefore be low for a good produced in a country which has an abundant endowment of the factor or factors of production which that good uses intensively. An unqualified statement of the Heckscher-Ohlin explanation of trade does not adequately deal with questions regarding the definition of factors of production. It is generally believed, however, that the Heckscher-Ohlin explanation of trade is broadly correct. It does succeed in stating the principle of comparative advantage in more acceptable terms than does the labour theory of value employed by the early classical economists.

---

[1] Bertil Ohlin, Interregional and International Trade, rev. ed. (Cambridge: Harvard University Press, 1967).

Both the classical and Heckscher-Ohlin trade theories, drawing on the principle of comparative advantage, have been stated here in "pure" terms. They have assumed, or at least have been presented in terms of, a barter style of exchange. The case may be restated, however. If a country has a comparative advantage in a particular product vis-a-vis another country due to an abundance of the factor of production used intensively in the creation of the product, it will be expected that this comparative advantage will be evidenced by the fact that the price of the product in the country with the advantage will be lower than in the second country. As trade takes place, these prices will tend to be equalized. This type of price convergence through trade is the basic idea behind the spatial equilibrium model.

It has been assumed to this point that there are no hindrances to trade such as transportation costs. When this assumption is relaxed, the price equalization process predicted under the spatial equilibrium analysis will no longer move to its former completion. The cost of transportation between two spatially separated markets, plus any other financial barriers, will be equal to a minimum price spread between them. When the difference in price between the two markets is reduced to this minimum, as it is expected to be after trade has occurred, it will no longer be profitable to move goods from the lower price market to the higher price one. A state of spatial equilibrium will have been reached. Transportation costs are only one form of trade hindrance to which this type of analysis is applicable. Another major type of barrier includes government trade regulatory instruments such as tariffs.

Tariff Theory

The standard format for analysing the effects of protection is to deal with tariffs and their operation within the price system. The reasons for doing so were discussed briefly in the first chapter of this study. The following descriptive analysis follows Kindleberger's expository format fairly closely.[1] The total effect of the tariff may be separated into a number of discrete effects. These do not, of course, operate in isolation from one another, but their separation does facilitate analysis and exposition.

Within the framework of partial equilibrium analysis, many of the effects of a tariff can be illustrated with reference to the first diagram, Figure 1.

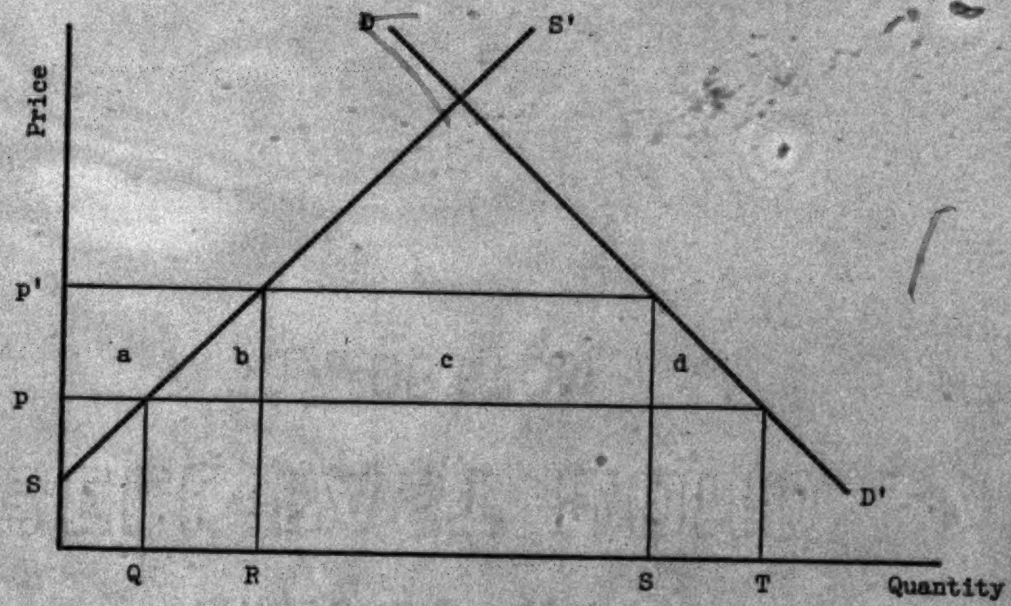
---

[1] Charles P. Kindleberger, International Economics, 5th ed. (Homewood: Richard D. Irwin, 1973), chap. 7.

FIGURE 1

PARTIAL EQUILIBRIUM ANALYSIS OF

TARIFF EFFECTS



The line DD' represents domestic demand and SS' represents domestic supply. The free trade price is assumed to be P and international supply is assumed to be perfectly elastic. The quantity imported at price P is QT, the difference between domestic supply and demand. When the price is raised to P' through the application of a tariff, domestic production increases from Q to R, domestic demand drops from T to S, and imports, being residual, become RS. The magnitude of these changes obviously depends on the domestic supply and demand elasticities.

One of the effects of the tariff is to redistribute income in favour of domestic producers of the protected product. The redistribution effect is represented in Figure 1 as area "a" and is the additional economic rent paid to preexisting domestic producers plus the rent paid to new producers above their supply price.[1] The redistribution in a more fundamental sense is between factors of production used in differing intensities in the creation of various goods. The Heckscher-Ohlin explanation of trade stated that countries benefit from intensive use of abundant input factors. Trade liberalization favours abundant resources, and conversely, trade restriction favours limited resources. Tariffs may therefore be the result of an attempt by owners of scarce factors to reduce the trade which threatens their favoured position. The pressure to remove tariffs, on the other hand, may be an attempt by owners of abundant factors to improve their position in a widening market. This latter point is true in that an increase in imports may, through normal commercial negotiations, lead to an increase in exports, which raises export prices and the rate of return to factors engaged intensively in export production.

---

[1] Area "a" in the diagram is rent in the economic sense in that it is a return to the factors of production over and above that which would be required to keep them in production. In Marshallian terms this amount is an addition to producers' surplus obtained through subtraction from consumers' surplus.

A second effect of the tariff, again within the framework of a partial equilibrium analysis, can be called the production effect, and is represented in Figure 1 by triangle "b". This area represents the misallocated resources used in producing amount QR domestically rather than buying it internationally at price P. The quantity of QR and the area of the production effect is determined by the elasticity of the supply curve. The production effect of the tariff therefore depends on factors which influence supply elasticity (such as the length of time being considered). It would be expected, for example, that the short term effect of a tariff would not involve a great deal of production distortion since short run supply elasticities tend to be small.

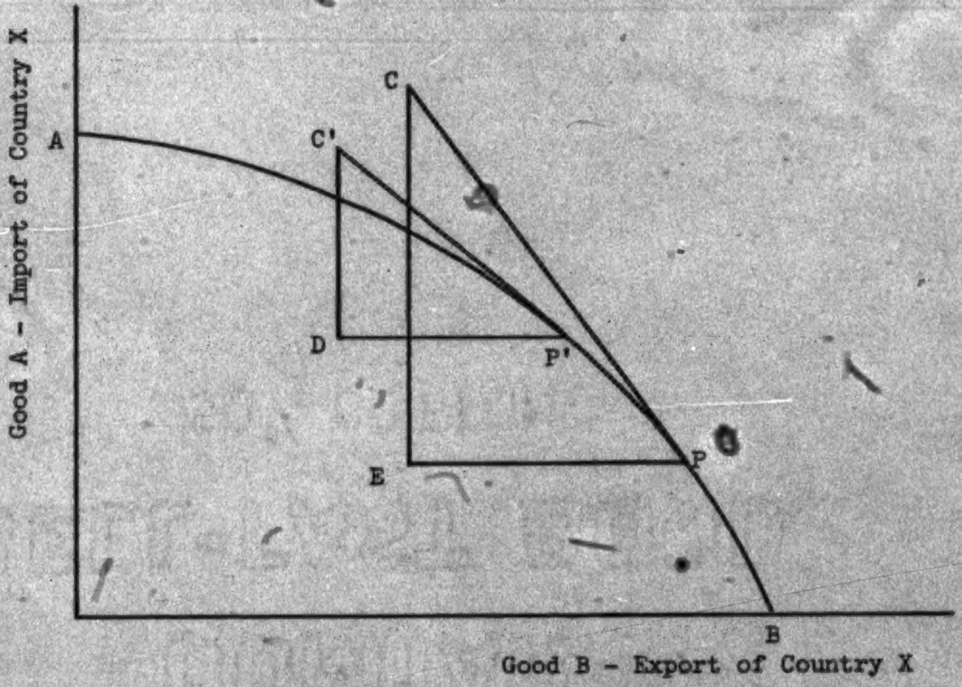
A third effect of the tariff is the revenue effect. It is represented by rectangle "c" in Figure 1. This area represents the increase in price times the remaining quantity of imports. It therefore represents the revenue accruing to the government through collection of the tariff duty on imports. Revenue considerations have historically been an important part of Canadian tariff policy. As late as 1929, revenue from customs duties provided 40 percent of federal government receipts and it was not until World War II and subsequent years that tariff revenue fell to less than 10 percent of total federal revenue. The revenue effect is no longer an important consideration in the formulation of tariff policy.

The final effect of the tariff is the consumption effect and is represented by triangle "d" in Figure 1. the increase in the price due to the addition of the tariff causes consumers to lose part of their "consumers' surplus" or unpurchased utility from consumption. The triangle "d" is therefore a distortion of consumption. The relative sizes of these areas, representing the values involved, are dependent upon the elasticity and position of the supply and demand functions and upon the prices involved.

The production and consumption effects dealt with here in a partial equilibrium analysis can also be analysed in general equilibrium analysis. The relevant diagram appears as Figure 2. The production possibility curve of country X is shown as line AB. The shape of this curve illustrates the assumption of increasing costs, essential to the theory of comparative advantage. The free trade production point is P while consumption is at C. This situation involves the export of quantity EP of commodity B, in which the country has a comparative advantage, in exchange for an import quantity EC. This exchange will be at the free trade price ratio of CP. The relevant community indifference curves which indicate, for example, that consumption will be at C rather than somewhere else on the price ratio line, are assumed but are omitted from the diagram. An uncritical dependence on community indifference curves must be carefully avoided here. There are many problems associated with their use, particularly under changing income distributions. When a tariff is imposed on the import of commodity A, its price will rise, as indicated by the new price ratio line C'P'. This will induce a production shift from P to P', indicating, as expected, an increase in the production of the protected good. The imposition of the tariff will also induce a change in consumption from C to C'. The shift illustrated in the diagram is composed of a decrease in the consumption of both commodities due to a relative increase in the cost of commodity A and the operation of both the income and substitution effects.

FIGURE 2

GENERAL EQUILIBRIUM ANALYSIS OF TARIFF EFFECTS



In addition to the effects described above, tariffs and other trade restrictions influence a country's equilibrium level of national income, its balance of payments and its terms of trade. In that the present study is not primarily concerned with the macroeconomic aspect of trade restriction, however, these areas of influence will not be discussed here. It is acknowledged, nonetheless, that they would be important in a comprehensive tariff study.

A final aspect in the consideration of the effects of trade protection is the area of non-economic results. It is necessary to take these into account in an evaluation of the costs and benefits of protection since they are potentially as important as the purely economic effects. Control of the rate of migration of labour out of agriculture or moderation of pressure on the agricultural labour force to make this adjustment is an important sociological goal in most countries. Labour's relatively inelastic supply in agriculture indicates that it cannot be shifted with complete ease to other sectors; serious sociological dislocation may result from a drop in agricultural income and excess pressure on labour to move to other sectors. This downward pressure, which may be the result of foreign competition, can be resisted by protectionist measures in trade policy. Countries may choose this approach to ameliorate a sociological problem, accepting in return whatever economic losses there may be. The Japanese example is a case in point here. Defense, national security and diversification of national production may also form important non-economic goals whose attainment must be balanced against economic costs.[1]

Summary

This chapter's discussion of the theory of trade restrictions, and in particular tariffs, has taken account of several important areas. One of these areas is the effect of tariffs on income distribution. A corollary of the Heckscher-Ohlin theory of trade is that trade liberalization tends to increase the returns to a country's relatively abundant factor or factors of production. Conversely, it was stated that increased trade protection tends to benefit a country's relatively scarce factor or factors of production. Such protection is almost always favourable for an industry or geographical region dominated by the protected activity. The country as a whole may lose, but the industry or region dominated by the industry in which the price is raised is likely to benefit, at least in the short run.

Another aspect of income distribution dealt with in the discussion was the effect of trade protection on consumers.

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[1] See H.G. Johnson, "An Economic Theory of Protectionism, Tariff Bargaining and the Formation of Customs Unions," *Journal of Political Economy* 73 (June 1965): 256 - 283. Johnson deals with the non-economic objective of diversification of national production and attempts a rigorous analysis within the price mechanism.

The partial equilibrium analysis indicated that consumers of a particular product lose a portion of the consumers' surplus which they derive from the product. Part of this loss to consumers is picked up by government in the form of tariff revenue, part is transferred to domestic producers of the protected product, and part is lost through distorted production and consumption. Such theoretical arguments fortify the complaints of consumer groups. When tariffs are applied to products whose consumption is widespread, as is the case with many food products, large portions of the domestic public are economically disadvantaged.

CHAPTER III

DISCUSSION OF METHODOLOGY

Analytical Objectives

The process of forming or adjusting economic policies needs to be based on reliable data and careful, comprehensive analysis. With Canada's large economic dependence on international trade, there are major potential gains or losses, depending on the trade policy which is followed. It is difficult, however, to understand and anticipate the many results of a particular policy. It is even more difficult to obtain a factual or quantitative basis from which to make trade policy recommendations and decisions.

In the preceding chapter, the theory of international trade and trade restrictions was surveyed. The information was drawn from a large body of theoretical literature. There also exists a large number of descriptive trade surveys which have primarily been concerned with assembling trade data in various ways and drawing conclusions directly from them. Most of these studies have made a very valid and valuable contribution to the understanding of international trade patterns and characteristics. There has, however, been relatively little work done on the actual quantitative analysis of trade.

The primary objectives of the present study fall into this area of the quantitative analysis international trade. Before specifying these objectives, however, some of limitations of the scope of the analysis will be explained. These limitations will be obvious in the later detailed description of the analysis, but will be discussed here in the context of the objectives in order to clarify the description of the analytical results.

First of all, the present study is limited to Canadian-American trade. One of the primary reasons for this is the wealth of availible data on bilateral trade between the two countries. The analytical procedure that was employed involved the use of a number of variables which would have been much more difficult or impossible to acquire on a multinational basis or for Canada and any other country. A second reason for selecting Canadian-American bilateral trade is that, at least from Canada's point of view, the United States is by far its major trade partner. It is true that the percentage of American agricultural trade involving Canada is much smaller than the percentage of Canada's trade with the U.S., but Canada is far from an unimportant trade partner of the United States. The value of trade between the two countries is, in fact, the largest in the world.

A second limitation of the present study is related to commodity selection and definition. In this case a primary concern was to keep the analysis within manageable proportions and thus limit the number of commodities considered. The choice of commodities for the present analysis has also been contingent upon the characteristics of the North American livestock market. Consideration was limited to those commodities in which there has been a recognizable volume of trade, commodities which have a trade flow between Canada and the United States of economically important proportions. This criterion eliminated, for example, Canadian imports of feeder cattle and hogs. The analysis in the present study has been limited to two commodity flows — the export of feeder cattle from Canada to the United States and Canadian imports of slaughter cattle from the U.S. This limitation was based on the decision that the examination of two commodity flows would be sufficient to adequately demonstrate the methodology and its suitability for quantitative trade analysis, and to answer some important questions about North American trade.

A final restriction of the scope of the analysis was the time span used. Since weekly observations were being used, the overall period was restricted to four years — 1970 to 1973 inclusive. During this span it was expected that the important characteristics and the most recent trends in the trade of the commodities would be in evidence. Furthermore, a time span of this length involved two hundred and eight weekly observations, a more than adequate number for statistical analysis.

With these limitations established, the objectives of the analysis can now be specified. The first is to add to the statistical basis of Canadian trade policy relating to the North American livestock market. There were a number of questions at this point to which answers were sought. What are the characteristics of the demand for cattle imports? What is the "tariff elasticity of demand"? What amount of protection do tariffs actually provide for the cattle industry and how does this compare with non-tariff barriers? Part of this objective will be to determine the elasticity of demand for imports of livestock within the North American market and to examine the relevance of this elasticity to the Canadian livestock producer.

The second objective of the analysis is to examine and to illustrate a methodological approach which would be applicable to other agricultural products and other markets. This, in a sense, is more important than the first objective. The limitations of the analysis have been discussed. Due to these, the generality of the analysis is also limited and it would be somewhat unrealistic to expect complete answers to questions posed under the first objective. What can be expected, however, is a demonstration of a methodology applicable to the analysis of other commodities.

Evaluation of Regression Analysis in the Present Context

Regression analysis is one of the most widely used and powerful techniques in statistical analysis. This is in large part due to its adaptability to an extremely wide range of problems and to the fact that its underlying concepts are fairly simple and straightforward. Regression refers to dependence and is conversely related to influence. The object of regression analysis is to specify in mathematical terms the influence of one variable upon another. It is important to realize, however, that when the influence of variable B upon variable A is mentioned, what, in fact, is being referred to in almost all cases is the influence of variable B and all other variables correlated with B, upon A. In an economic world so characterized by interdependency, it is only rarely that B is not correlated with many other variables that have an influence on A. By adding further variables to the regression model it is possible to study the influence of variable B and all other variables correlated with it, except for C, D and other included variables, upon the dependent variable A.

In essense, it is possible to separate the individual influences of the various specified variables. The more variables that are included in the analytical model, the closer the researcher comes to being able to state the true influence of each explanatory variable upon the dependent variable, and to being able to completely explain the variance in the latter. A point is soon reached, however, beyond which additional variables explain only insignificant portions of the variance of the dependent variable. The procedure adopted, therefore, is to select those variables which are expected, in line with accepted economic theory, to have the greatest explanatory capability. While interdependence among these variables is ubiquitous, its quantitative importance diminishes rapidly after the most influential variables have been taken into account, and these most influential variables are usually few in number.

This discussion of regression analysis applies to the methodology used in the present study. In econometric terms a primary objective of the study has been the determination of two demand functions — the function applying to the Canadian demand for slaughter cattle imports from the U.S.A., and the function applying to the American demand for imports of feeder cattle from Canada. The determination of these demand functions involved a number of assumptions regarding the nature of supply and demand curves. The observations of price and quantity at any point in the time series analysis are given the economic interpretation of intersection points of short run supply and demand curves. At these points in time it is also possible to collect data on other relevant factors. The fluctuation in observable values of price and quantity is attributed to the lateral movement of the supply and demand curves, caused by changes in the related and influencing factors. If one of the curves were to remain fixed and the other one were to vary widely, points along the stationary curve would be observed. Even if the movement of one curve were restricted while the other one had a wide relative variation, it would be possible, with some certainty, to estimate the nature and position of the first one. This reasoning has direct bearing on the selection of variables for the analysis of demand fuctions and on the analytical techniques employed. Observations of price and quantity are included, of course, since they are integral to the definition of supply and demand. Quantity normally appears as the dependent variable in the demand function. If all factors other than price were held constant, the demand curve would be stationary and its specification exact.

The regression analysis technique, as discussed above, allows the inclusion of other variables influencing demand and thus, provides the capability of removing their influence from the analysis. The lateral movement of the demand curve over time is thereby reduced relative to that of the supply curve, and a more accurate estimation of the function is facilitated. Those variables having the most significant effect on the demand for the commodity are therefore included in the regression model.

An alternative approach to the problem of identification is the "simultaneous equation technique". While this is a more sophisticated technique mathematically, there was felt to be no inherent reason for its use in this analysis. While it has the capability of simultaneously considering supply and demand, its use in a situation involving autocorrelation, which was anticipated in this analysis, would greatly complicate the analysis. Without compelling reasons for its use, the decision was made to limit the analysis to the single equation technique.

A second feature in the development of a regression analysis model is the specification of the functional form of the demand relationship. Whereas in some statistical problems the relevant theory will either suggest or directly specify the appropriate mathematical form to be used, the theory relating to the demand for imports does not do so. While there may be expectations regarding the elasticity of the curve, there is no way of predicting whether the relationship will be linear or some form of non-linear relationship. In such cases the procedure often followed is to test a number of forms and to select the one giving the best statistical results. While a linear functional form is the only one used in the statistical analyses discussed in the next chapter, the subject of alternate functional forms is not forgotten, but is discussed at the appropriate point.

There are a number of statistical techniques for carrying out regression analysis, two of which are employed in this study. The first of these, the simple least squares estimation procedure, is the standard approach. The specification of a hypothetical functional form is the first step in carrying out least square estimation. The mathematical equation will include one or more terms describing the influnce of the independent variable or variables on the dependent variable, and a stochastic or error term which encompasses the unexplained variance in the dependent variable, including errors in measurement. The simplest two variable linear relationship would be expressed by:

$$Y = \alpha + \beta X + u$$

in which Y is the dependent variable, X is the single independent variable, and u is the error term. The objective of the least squares estimation method is to determine values for the coefficients α and β, which will provide the best fit of the functions to the data. This fitting is accomplished by minimizing the sum of squared difference between the predicted and observed values of Y. In essence the method minimizes the amount of unexplained variance in the dependent variable.

Least squares estimation is based on a number of vital assumptions which, if unfulfilled, will seriously limit the reliability of the results. These assumptions relate to the error term and are: (1) that its expected value will be zero, (2) that its variance will be constant and independent of the independent variables, and (3) that the various values of the error term will be independent of each other. It is also essential for completing least squares estimation that the number of observations exceeds the number of parameters to be estimated.

The assumption that the values of the error term will be serially independent is often unfulfilled in time series analysis. There are a number of reasons for this, particularly in the investigation of agricultural production or marketing. In these areas there are numerous cyclical patterns in prices and quantities. If these cyclical influences are not completely accounted for in the explanatory variables they will cause serial correlation, or autocorrelation in the error term. While autocorrelation does not cause biased estimates of the parameters, it does cause unduly large sampling variances and inefficient prediction. It also means that the precise forms of the "t", "F", and "R^2" tests will no longer be valid.

It is in response to problems such as these that altemnative approaches to statistical estimation have been developed. One alternative approach was developed to deal with the problem of autocorrelation and was proposed by D. Cochrane and G.H. Orcutt.[1] The procedure which they developed was based on the assumption of a first order autoregressive situation in which the error term in period t is correlated with the error term in t-1, the immediately preceding period. An estimate of this correlation is made by regression analysis and the resulting coefficient, rho, is used to transform the original data. Least squares estimation is then performed on the transformed variables, new error terms are again produced, and a new estimate of rho is calculated. The iterative process normally stops either when significant autocorrelation is no longer detected or when there are insignificant changes in the estimate of rho from one iteration to the next.

In the next chapter the statistical problem of multicollinearity, which exists when two or more of the dependent variables in the regression model are highly or perfectly correlated , is dealt with. Like autocorrelation, multicollinearity reduces the reliability of the estimated regression coefficients and makes it difficult to draw sound conclusions from the analysis. A distinction between the two problems is that while autocorrelation can be handled by various estimation techniques, multicollinearity necessitates a respecification of the regression model and the variables employed. Further discussion of the various statistical procedures and of the way in which they were used in the present analysis also appears in the next chapter in conjunction with a discussion of the analytical results.

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[1] D. Cochrane and G.H. Orcutt, "Application of Least Squares Regression [illegible] Relationships Containing Auto-Correlated Error Terms," Journal of the American Statistical Association 44 (1949): 32 - 61.

Review of Related Studies

Two studies have had particular influence on the development and characteristics of the present thesis. They will be discussed here in order to indicate both the nature and destinctive differences of each, as well as to describe the characteristics which were incorporated into the present study.

The objective of "Price Effects of the Kennedy Round on Canadian Trade," by L.H. Officer and J.R. Hurtubise[1] was to forecast the price effects of the Kennedy Round of GATT negotiations on Canadian trade with the United States. The work was partially predictive in nature in that it was published in 1969 and the final results of the Kennedy Round negotiations were not put into effect until 1972. This predictive characteristic of the Officer-Hurtubise study is in contrast with the descriptive nature of the present study. The purpose of the latter has been to specify the relationship between tariff level and trade volume which has been in effect during the period under consideration. The results of the present study are expected to be relevant to the future, but while Officer and Hurtubise employed extrapolation in their analysis, the present study has derived results strictly from within the observational period.

The Officer-Hurtubise study and this study have a strong similarity in that both seek to detail the effect of the tariff as a regulatory instrument on the volume of Canadian-American trade and on individual commodity trade balances. Officer and Hurtubise approached this problem, however, by examining one descrete tariff change and predicting its effect on future trade. The present study, on the other hand, has attempted to determine the dynamic

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[1] L.H. Officer and J.R. Hurtubise, "Price Effects of the Kennedy Round on Canadian Trade," Review of Economics and Statistics 51 (August 1969): 320 - 333.

relationship between the level of the tariff and the level of trade. Both papers have employed the tool of regression analysis and in particular the single equation technique for estimating and identifying demand curves. In the Officer and Hurtubise study the tariff effect was determined through the inclusion of the tariff in the price variable and the subsequent examination of two cases involving different tariff levels. The predicted difference in trade volumes was then attributed to the alteration in the tariff. Within the present study the tariff is examined in a number of different ways. It is included, in some of the analytical sequences, as a separate independent variable. In one sequence it is treated as a structural rather than a dynamic factor and in others it is assumed to be part of the price variable.

Another distinction between the two studies is apparent in the area of commodity definition. Officer and Hurtubise defined broad commodity groups such as Fuel and Lubricants, Construction Materials, and Food. Trade volumes had to be measured in the only common unit — dollars. The present study has dealt with only two commodities, slaughter and feeder cattle, and so has been able to use physical units as a measure of trade volumes. This avoids the necessity of deflating dollar values to constant dollar terms..

The more disaggregated commodity definition used in the present study was also selected beause of the particular nature of Canadian-American livestock trade. The broad category of livestock and livestock products is composed of many distinct commodities which are traded in their own distinct markets. These commodities may have discernable cross-price elasticities between themselves, but they do not respond homogeneously to forces of supply and demand. Slaughter cattle are a different product from feeder cattle and the two may, and often do, move simultaneously in opposite directions across the Canadian-American border. Any attempt, therefore, to analyse livestock or even cattle as a single commodity will be unable to distinguish the most important characteristics which their trade exhibits.

The form of the demand equation used in the estimation procedure of Officer and Hurtubise is:

$$T = a + b(\Sigma w_iP_i) + cA + dB + eQ_1 + fQ_2 + gQ_3 + u$$

in which:

T = trade flow in constant dollars

P = ratio of price index of trade flow to price index of competing domestic products

w = weighting factor used in distributed lag

A = activity in importing country

B = other influences on demand (dummy)

Qj = seasonal dummy; 1 if jth quarter, 0 otherwise

u = error term

The price variable used by Officer and Hurtubise is a price ratio used with a distributed lag pattern. The ratio, as mentioned above, is that of the index of the price of imports to the price index of competing domestic products. In the present study the price ratio was replaced by a slightly different variable, the price spread. It was felt that this was a more realistic indicator of the profitability of trade.

Officer and Hurtubise investigated six different weighting patterns for the distributed lag of the price variable. These included four and eight quarter lags and linear, quadratic and cubic weight distribution patterns. For each commodity group the pattern giving the best results was selected. Canadian imports of food products, for example, showed the best results with an eight quarter quadratically distributed lag on the price variable. In the present study, considering that weekly and monthly, rather than quarterly data were being used, it was expected that the same distributed lag patterns would not be effective. There was, however, an attempt made to investigate their applicability to the present problem. It was found that no significant improvement in the analytical results was achieved by introducing a distributed lag to the price variable. The results of this investigation are discussed in the next chapter.

Officer and Hurtubise included seasonal dummy variables in order to account for up any seasonal variation in trade volumes. These variables appeared to have a significant explanatory effect in most cases. Their exclusion from the present study was primarily due to the use of weekly and monthly data.

A final point to be mentioned with regard to the Officer and Hurtubise study is their approach to the problem of autocorrelation. Both the least squares regression technique and a technique devised by C. Hildreth and J.Y. Lu for removing autocorrelation were used. The Hildreth-Lu technique is very similar to the Cochrane-Orcutt procedure used in the present study. The results obtained by Officer and Hurtubise show a significant decrease in autocorrelation, as indicated by the Durbin-Watson statistic, through the use of the Hildreth-Lu technique.

As mentioned, two studies have had an important influence on the development of the present one. The first is that by Officer and Hurtubise, the second is by Peter Tryfos and is entitled "An Economic Model of the Canadian Red Meat System for Policy Analysis."[1] The Tryfos study also has a number of similarities to the present study, but differs in a number of important points as well. Peter Tryfos gives the following description of his work:

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[1] Peter Tryfos, An Economic Model of the Canadian Red Meat System for Policy Analysis (Ottawa: Agricultural Economics Research Council of Canada, 1974).

> The study provides a quantitative description of the Canadian livestock-meat system. It focuses on major economic variables such as livestock prices, wholesale and retail meat prices, consumer demand for meat, livestock inventories and supply, imports and exports, wages, and employment in the meat processing industry. It provides measurements of the relationships among these variables, and brings the measurements together to form a model of the industry as a whole. The degree of success of the estimated relationships in capturing the past behaviour of the system, in forecasting its future performance, and in evaluating the likely effect of alternative policies is extensively examined.[1]

The components of the model are examined under five headings: prices, consumer demand, wages and employment, livestock inventories and supply of livestock meat, and exports and imports. Imports and exports of livestock meat are not dealt with directly in the Tryfos model. The hypothesis is made, however, that because of the open nature of the industry in both Canada and the U.S.A., and because of the much greater size of the American industry, American livestock prices will determine the approximate level of Canadian prices. Tryfos discusses and uses the concept that Canadian prices will fluctuate within a certain range around the equivalent American prices and that their leeway relative to the American prices will be determined by such obstacles to trade as tariffs and transportation cost. This is a concept which is important in the present study as well.

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[1] _Ibid._, p. 2.

The analytical method employed in the Tryfos study is the simultaneous equation technique of regression analysis. Since both the independent variables and the regression technique differ from the present study, a description of the details of Tryfos' work will not be included here.

In summary, it can be stated that particular aspects of the present study have been derived from the work of Officer and Hurtubise and of Tryfos. Many of the analytical details, and in fact the objective of the study, have been taken more or less directly from Officer and Hurtubise. The contributions of Tryfos' publication have primarily been in the area of concepts relating to the Canadian and American livestock markets. Characteristics of the present study which have not been taken from either of these studies have had other sources and have evolved over the course of the present investigation under the influence of the original objectives and considerations of practicality.

Discussion of Data

The selection of variables and the collection of data are normally governed by the requirements of the methodology being used. One of the important factors governing the selection of variables is the particular commodity definition being employed. Commodity definition, in turn, is influenced by the characteristics of the market being studied. In the North American livestock market a number of commodities can be distinguished by the similarity of their movements within the market. Feeder cattle and slaughter cattle are two such products. The selection of these particular commodities and their markets determines, to some extent, the relevant variables to be included. The discussion of these variables will proceed on a sequential basis, including the description of the variable, the source of the data, the reason for the variable's selection and an estimation of its relevance in the analysis. A complete citation of the sources mentioned appears in the Bibliography. The variables used in this study are as follows:

1. The Canadian-American Exchange Rate

This variable expresses the price, in Canadian dollars, of one American dollar. Weekly quotations of the Canadian-American exchange rate were taken from the statistical tables of the Bank of Canada Review and from the Financial Post.

2. Trend Variable

This variable consisted of the numbers 1 to 208, one for each observation. Inclusion of this variable served in determining any secular trends over the period of the analysis. The exchange rate and the trend variable were included in the analysis of Canadian imports and exports.

3. The Volume of Slaughter Cattle Imports

This variable is expressed in number of head of cattle imported per week from the United States for immediate slaughter. Data were collected from the Livestock and Meat Trade Report and constituted the dependent variable in the analysis of slaughter cattle imports. It is a quantitative measurement of Canadian import volume and does not involve either averaging or estimation.

4. The Volume of Feeder Cattle Exports

This variable is the number of feeder cattle over 200 lbs. exported per week to the United States. These cattle are distinguished from slaughter cattle by the fact that they are sold for feedlot finishing rather than for immediate slaughter. Data were collected from the Livestock and Meat Trade Report.

5. The Toronto Slaughter Cattle Price

This is the weekly average price of the bulk of sales at public stockyards in Toronto of choice and A1 and A2 steers, expressed in dollars per hundredweight. The data were acquired again from the Livestock and Meat Trade Report . Due to a change in the Canadian beef grading system at the beginning of September, 1972, the grade reported changed from choice to A1 and A2 steers. The correspondence of these, while not exact, was close enough to avoid serious dislocation of the price series.

The selection of this and other price variables described below was based on two assumptions. One assumption was that the market in question is an important price reporting centre for the particular commodity. In the case of slaughter cattle, the Toronto price is used as a proxy for a "Canadian price". This assumption is based on the fact that the most important geographical movements of the commodity involve the particular market in question. Slaughter cattle imports, for example, move primarily into the Toronto area. This assumption applied as well to the selection of other price reporting centres.

A second assumption involved in the selection of these price variables is that there is a high degree of correlation between the price per pound of the various grades of slaughter cattle. This correlation allows the use of the price of A1 and A2 or choice steers as a proxy for the average of all slaughter cattle prices. These assumptions are not the subject of the present analysis and are therefore not tested here, but are based on an understanding of the nature of the markets involved. The fact that the acquisition of the data in this and the other price variables involves some degree of averaging and dependence on the two stated assumptions means that these variables are neither as accurate nor as dependable as the volume of trade variables discussed earlier. Another important factor is that they are not exactly what is required. A "true Canadian price" is what is desired, but it does not exist. A proxy of this type is therefore used as the best alternative.

6. The Omaha Slaughter Cattle Price

This variable, taken from the U.S.D.A. Livestock, Meat, Wool Market News, expresses the weekly average price in dollars per hundredweight of choice steers (900 - 1100 lbs.) at Omaha. Assumptions involved in the use of American prices are the same as those specified for the Canadian equivalent. Close correlation between the price movements of the various grades of cattle is again assumed, and Omaha is taken as the predominant trade centre for American slaughter cattle. Qualifications similar to those expressed for the Toronto steer price again apply.

7. The Calgary Feeder Cattle Price

The data comprising this variable constitute the weekly average price, in dollars per hundredweight, of good feeder steers prior to September, 1972, and steer calves (401 - 575 lbs.) after that date, at Calgary. The reason for the change in the variable at September, 1972, was the change in the Canadian beef grading system at that date. The Calgary price was one of three Canadian prices used to estimate a Canadian average price for feeders. The reason for establishing this Canadian average price was that no single market was believed to predominate in the Canadian feeder attle trade, and that a three market average would be the best proxy for the "true Canadian price". The data were taken from the Livestock and Meat Trade Report.

8. The Winnipeg Feeder Cattle Price

The data comprising this variable are the weekly average prices of steers at Winnipeg, in dollars per hundredweight. Prior to the change in the grading system in September, 1972, the price of good feeder steers was used, and after that date the price of steer calves (401 - 575 lbs.) was used. In all respects this variable is analogous to the Calgary feeder cattle price.

9. The Edmonton Feeder Cattle Price

This variable is again analogous to points 7 and 8. The prices are weekly averages of the same grades of feeder cattle, at Edmonton, and are again expressed in dollars per hundredweight.

10. The Kansas City Feeder Cattle Price

This variable expressed the weekly average price in dollars per hundredweight of good feeder steers, 500 - 600 lbs., at Kansas City, and the data were taken from the U.S.D.A. Livestock, Meat, Wool Market News. Kansas City is the predominant feeder cattle market in the U.S.A. The price of feeders at that market was therefore chosen as a proxy for an average American feeder cattle price.

11. The Toronto Steer Carcass Price

This is the average weekly price, in dollars per hundredweight, of A1 and choice steer carcasses at Toronto. This variable was taken from the Livestock and Meat Trade Report. The choice grade figures were reported prior to the change in the beef grading system, and the A1 steer carcass prices were reported after the change. The two grades have enough equivalence to be considered compatible.

12. The American Cattle Feed Price

This is the national average price taken at mid-month, in dollars per hundredweight of beef cattle feed concentrate, 30 percent protein and over. Data were taken from the U.S.D.A. Agricultural Prices, a monthly publication. Since only one figure is published for each month, the procedure used was to repeat it for each weekly observation within the month. This introduced a small amount of error which, along with the averaging and selection, limited the accuracy and dependability of the data.

13. The Canadian Import Tariff on Slaughter Cattle

This variable is the amount of duty, in cents per lb., charged on Canadian imports of American cattle for other than breeding purposes. The data were taken from the Canadian Customs Tariff and from personal correspondence with Mr. J. Loomer, Director of the Tariffs Section of the Federal Department of Finance.

The North American Livestock Market

A number of studies have provided descriptive details of the Canadian livestock and red meat industry and of Canadian-American trade in livestock and meat.[1] While not attempting to duplicate this literature, a brief description of the major characteristics of these markets will be germane to the development of this study.

Table 1 summarizes the location and magnitude of human population, cattle production and cattle slaughter in Canada in 1971. While population concentration is not identical to demand concentration, the regional differences in per capita demand for beef are not great enough to cause notable differences between population and demand patterns. Table 1 is particularly illustrative of regional discrepancies in the supply and demand for cattle and beef. Comparison of the three columns shows the balance of live cattle production, meat production through slaughtering and the demand for meat in the various provinces and regions. Generally, eastern Canada has a deficit in both live cattle and meat, while western Canada has a surplus in both. These deficits and surpluses are balanced by the shipment of both live cattle and carcasses within Canada and by movements of livestock and meat between Canada and the United States or other countries. Table 2 illustrates the average annual eastward movement of cattle in two recent five year periods. The total number of cattle and calves moving from western to eastern Canada is equal to approximately 10 percent of total Canadian slaughter each yeTABLE 1

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[1] Among those recently published are: A. M. Boswell, "The Changing Profile of Canada's Beef and Veal Trade," _Canadian Farm Economics_ 8 (October 1973): 1 - 14; Agriculture Canada, "Commodity Background Paper No. 1 : Livestock," (working paper for preperation for GATT negotiations, Summer 1973); K. D. Smith, "The New Canadian Beef Grades," (M.Sc. thesis, University of Alberta, 1974); V. W. Yorgason, _Canada's Livestock - Meat System_ (Ottawa: Agricultural Economics Research Council of Canada, 1973).

CANADIAN GEOGRAPHICAL DISTRIBUTION PATTERNS OF HUMAN POPULATION, CATTLE PRODUCTION, AND CATTLE SLAUGHTER, 1971

	Population	Cattle Production	Cattle Slaughter
	percent	percent	percent
Atlantic Provinces	9.4	2.3	1.3
Quebec	27.4	7.9	7.1
Ontario	36.0	21.6	32.8
Total Eastern	72.8	31.8	41.3
Manitoba	4.6	9.5	15.3
Saskatchewan	4.3	22.0	5.6
Alberta	7.6	32.6	36.4
British Columbia	10.7	4.1	1.4
Total Western	27.2	68.2	58.7
Total Canada	100.0	100.0	100.0

Sources: Population - Statistics Canada, 1971 Census of Canada (Ottawa: Statistics Canada, 1971).
Cattle Production - Number of cattle, other than milk cows, on farm -- average of June 1 and December 1, 1971. Statistics Canada, Livestock and Animal Products Statistics, Cat. no. 23-203 (Ottawa: Statistics Canada, 1971).
Cattle Slaughter - Cattle slaughtered in inspected establishments. Statistics Canada, Livestock and Animal Products Statistics, Cat. Cat. no. 23-203 (Ottawa: Statistics

Canada, 1971).

TABLE 2

CATTLE AND CALVES, AVERAGE ANNUAL SHIPMENTS FROM WESTERN TO EASTERN CANADA, 1961-1971

	To Feedlots	To Stockyards	To Packing Plants	Total
	...'000 head...			
1961-66	283.5	54.5	109.0	447.0
1966-71	320.5	56.5	106.0	483.0

Source: Statistics Canada, Livestock and Animal Product Statistics, Cat. no. 23-203 (Ottawa: Statistics Canada, 1971).

The various surpluses, deficits and flows of live animals and dressed meat have been reflected in price differentials within Canada and between the Canadian and American markets. Two important features of the price structure in the North American market can be mentioned. The first is that the North American livestock and meat market has tended to operate according to the expected characteristics of a spatial equilibrium model.[1] Prices for similar products normally differ by an amount equal to transportation and other charges, such as tariffs, applying between them. Canadian and American prices have therefore undergone similar movements, though not always in perfect unison nor at the same level. The spatial equilibrium model applies to an even greater extent between eastern and western Canada.

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[1] This concept is extensively relied upon by Peter Tryfos in his study, An Econometric Model.

The second feature of the North American market is the dominant influence of U.S. prices on Canadian prices. Peter Tryfos demonstrated the extent to which this is true in his study.[1] Because of the great difference in the size of the Canadian and American markets, a given volume of trade in livestock or meat in either direction between the two countries will have a much greater effect on Canadian Since the effect of Canadian prices on prices in the United States is very small or negligible,[2] it can be said that American prices determine those in Canada. The range within which Canadian prices can fluctuate relative to American prices is controlled by the barriers to trade between the two markets. If such things as transportation costs, tariffs, and non-tariff barriers increase, there is a corresponding increase in the leeway for Canadian prices to move relative to U.S. prices without triggering off-setting trade flows. Given prohibitive trade barriers and an absence of trade, there would be no necessary correlation between prices in the Canadian and American markets.

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[1] Ibid., p. 11.
[2] Ibid., p. 114.

In considering the North American cattle and beef system it is important to look at the various marketing channels and the way in which they function. Perhaps the most notable characteristic of the whole system is its diversity. It is not possible, therefore, to make simple definitive statements about the way in which product flows from producer to consumer. However, keeping in mind the possibility of exceptions, a general description of marketing channels and practices can be given. Reflecting the emphasis of this study in general, this section deals only with live cattle.

An important historical development in beef cattle production has been the great increase in feedlot finishing of animals. This change has meant increasing specialization of producers in either cow-calf or finished beef operations. Within these phases of operation two main sources of beef can be distinguished: that from regular beef breeds, and that from dairy breeds either as dairy animals or as dairy-beef crossbreeds. The cow-calf operation involves maintaining a herd of breeding females and producing weaned calves of about 400 lbs. Calves of this weight may be sold as feeders and steers or retained for finishing. Much of Canada's production of finished veal calves comes from the dairy herds of eastern Canada, which may be considered a form of cow-calf operation. In both eastern and western Canada the cow-calf enterprise utilizes low cost forage as the major feed input. The beef feeding enterprise may involve feeding and finishing either the farmer's own calves or calves and yearlings which have been purchased specifically for feeding and finishing. Feedlot finishing in Canada is located primarily in southern Alberta and western Ontario. Management decisions and profit margins in the feeding enterprise will depend on such factors as the cost of feed, the price spread between feeder and slaughter cattle, and the length of time the animals are kept. Finished animals are normally marketed in the 900 - 1100 lbs. range.

Operating in conjuction with this type of beef producing system is an array of marketing channels and facilities. The overall purpose of the marketing system is to move animals from producers to meat packers and processors and dressed meat to consumers. This process often involves extensive geographical movement. Cattle and calves may enter the marketing system many times before slaughter, either through public or private sale, depending on market conditions, the type of animal and individual producer decisions. Between the cow-calf producer and the meat packer, the animal may pass through one or more public stockyards, auction markets, country dealers, or terminal markets. Public stockyards and auctions are important markets for feeder cattle and calves, while direct sales of slaughter cattle to packing plants has become increasingly important.

International trade in livestock and meat is another factor in the marketing system. Exports to the U.S. of live beef under 200 lbs. are primarily calves for veal slaughter, with a smaller but increasing number going for futher feeding. Most of the live veal exports originate in eastern Canada, mainly in Quebec and to a lesser extent in Ontario, and are a secondary product of the dairy sector. The main American markets are in New York state, the New England region, and Michigan. Live exports to the U.S. of beef cattle between 200 and 700 lbs. are basically feeder cattle. These animals move primarily from the Canadian prairies, particularly Alberta, to the American Midwest and southwestern states. Over the past decade there has been a decrease in this class of cattle export due to a growing demand for feeder cattle in western Canada and the retention of heifers for Canadian herd expansion.[1] Live cattle over 700 lbs. exported to the U.S. consist of heavy feeders and low grade slaughter cattle for boneless beef purposes. Fed cattle exports are sporadic, reflecting Canada's general deficit in finished beef production. Canadian imports of feeder cattle are negligible. This fact is a reflection of

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[1] During the 1970 to 1973 period the average weekly American import of Canadian feeder cattle was 943 head, while the range of these imports was from 0 to 11,780 head and the standard deviation was 1,668 head. Figure 5 in Appendix 1 is a graphic illustration of weekly American feeder imports from Canada.

Canada's feeder cattle surplus and not of Canadian import restrictions on feeder cattle. The applicable restrictions are listed in Table 3. Canadian imports of live slaughter cattle are primarily from feedlots in the American Midwest. These animals move into the beef deficit areas of Canada, mainly through the Toronto market into Ontario. Their import is largely dependent on the relationship of fed cattle prices on both sides of the border.[1]

Besides these trade flows, Canada has an important volume of trade in purebred and dairy cattle. With increased emphasis on breed improvement and performance, purebred exports and imports have increased greatly, particularly in value.

In concluding this discussion of Canadian cattle marketing and trade with the United States, both countries' trade barriers for live cattle are presented. Historically these barriers have not been severe or restrictive in nature. However, in the recent past, including a period not dealt with in this study's major analysis, there have been changes in Canadian and American trade regulations which have become more openly restrictive and much more decisive in their control of trade volumes. The various barriers, existing at this time, are listed in Tables 3 and 4.

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[1] During the 1970 to 1973 period the average weekly import of American slaughter cattle was 1830 head, while the range of these imports was from 0 to 20,401 head and the standard deviation was 3,490 head. Figure 3 in Appendix 1 is a graphic illustration of weekly Canadian slaughter cattle imports from the United States.

TABLE 3

AMERICAN REGULATIONS ON IMPORTS OF LIVE CATTLE FROM CANADA

(M.F.N. Tariff Rate Applicable)

..... all rates in cents per pound .....

Item	Rate	Date of Effectiveness	Surcharge
1. Cattle for breeding	Free	No dates availible	All items listed were subject to an additional 10% ad valorem duty between Aug. 15, 1971 and Dec. 1, 1971.
2. Cattle under 200 lbs			
a) within quota of 200,000 head per year	1.5		
b) in excess of quota	2.5		
3. Cattle 200 to 700 lbs.	2.5		
4. Cattle over 700 lbs.			
a) dairy cows	0.7		
b) other cattle within quota of 400,000 head per year or 120,000 head per quarter beginning April 1	1.5		
c) other cattle in excess of quota	2.5		

TABLE 4

PROGRESSION OF CANADIAN REGULATIONS ON IMPORTS OF LIVE CATTLE FROM THE UNITED STATES (M.F.N. Tariff Rate Applicable)

..... all rates in cents per pound .....

Item	Rate	Date of Effectiveness	Surcharge
1. Cattle for breeding	Free	November 30, 1906	
2. All other cattle	1.5	June 1, 1950	
	Free	February 20, 1973	
	1.5	September 22, 1973	
	"	November 3, 1973	3
	"	January 13, 1974	2
	"	January 27, 1974	1
	"	February 10, 1974	

Live cattle moving in either direction between Canada and the United States are subject to health regulations. The two diseases for which tests are made are bovine brucellosis and tuberculosis, and traded cattle moving in either direction must be accompanied by certification of testing or vaccination for both of these. Imports to the U.S. may also encounter further state regulations. California, for example, requires brucellosis vaccination on all cattle. More stringent requirements are also in effect for trade in dairy cattle.

Analytical Design and Assumptions

The choice of variables to be used in the investigation of the trade flows — Canadian slaughter cattle imports and feeder cattle exports — was based on a knowledge of the North American cattle market. The various characteristics of the market were treated as expectations to guide the initial steps of the analysis, but were later to be tested themselves and demonstrated or disproved by the results of the analysis.

In the case of slaughter cattle imports, the primary expectation about the operation of the North American market was that the price differential of spread between Canadian and American slaughter cattle prices would be the prime determinant of the volume of imports. Another expectation, which affected the form of the price spread variable, had to do with the geographical flow pattern for slaughter cattle moving from the U.S.A. to Canada. As mentioned earlier, it is believed that a majority of these animals move from the American Midwest to Ontario. Therefore, the markets from which the price variables were taken were Omaha and Toronto. It was expected that the price spread between these two centres would be representative of the "true" Canadian-American price differential. Such factors as the number of Canadian and American slaughter cattle marketed domestically, the price of substitute products such as pork and lamb, and the level of consumer demand were expected to be reflected on slaughter cattle import volumes through the slaughter cattle price itself. Due to the supposedly close commercial linkages between the cattle and meat industries in the two countries, it was not expected that there would be an appreciable lag in the response of volume imported to changes in the price spread. The procedure adopted in this study for getting around the "identification problem" was discussed earlier in this chapter. In accordance with such a procedure, factors were sought which would have a bearing on the demand for the product, imported slaughter cattle. One of these was the price of beef carcasses in Canada. Since the demand for raw products is derived from the demand for the processed equivalents, it was expected that the demand for slaughter cattle would be derived from and thus related to the demand for carcass beef and, in turn, retail cuts of beef. The price of carcass beef was taken as the short run indicator of demand, and the market in which this was measured was the same as for live cattle -- Toronto. Other variables included in the explanatory equation for Canadian slaughter cattle imports were the Canadian-American exchange rate, the tariff rate and a trend variable. The first two were expected to act in conjunction with the price spread variable. They were, however, entered as separate variables in an attempt to determine their individual effects on import volume. The trend variable was entered in an attempt to detect any long run secular shifts in import volume.

The volume of Canadian feeder cattle exports to the U.S.A. was expected to respond to changes in a Canadian-American price spread. Distinct from the slaughter cattle trade pattern, the flow of Canadian feeder cattle southward does not involve closely definable areas. The flow is believed to be from the Canadian prairies to the American Midwest and southwestern states. Whereas Omaha is the predominant slaughter cattle market, Kansas City is the primary feeder cattle market. The price spread utilized in the analysis was that between the Kansas City price of feeders and the simple average of the Calgary, Edmonton and Winnipeg markets.[1]

Another important factor in determining the American demand for Canadian feeder cattle is the profitability of feeding cattle, or more precisely, the expected profitability. Taking the simple assumption that expectations of profitability are based on present prices, a variable was devised to measure this profitability expectation — the ratio of feed costs to slaughter cattle prices. Another assumption involved is that the feed conversion ratio is fixed over time, or at least over the period of observation. The ratio of feed costs to slaughter cattle prices was felt to be an adequately realistic variable in that feed costs comprise the great bulk of cattle feeding cost, and their relationship to fed or slaughter cattle price would give some idea of the variation to be expected in the cattle feeding profit margin.

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[1] A weighted average of the price of feeders at Calgary, Edmonton and Winnipeg might have been more accurate than the simple average. The change in the final results and conclusions would, however, have been marginal.

These two explanatory variables, the price spread and the feed ratio, were the only ones used in the analysis of feeder cattle exports. All American prices were transformed, through multiplication by the exchange rate variable, to Canadian prices. Discussion of these variables is continued in the next chapter, together with a complete description and discussion of the analytical results.

CHAPTER IV

DISCUSSION OF ANALYTICAL RESULTS

Canadian Slaughter Cattle Imports

Analytical Sequence 1

The previous chapter dealt with both the collection of data and the selection of the variables employed in the analytical process. As mentioned, the independent variables for the analysis of both Canadian imports of American slaughter cattle and American imports of Canadian feeder cattle were chosen because of their expected ability to explain the variation in the particular trade flow in whose analysis they were used. The variables utilized in the initial investigation of Canadian slaughter cattle imports were a)the Canadian-American price spread for slaughter cattle (Omaha minus Toronto), b)a trend variable, c)the price of beef carcasses in Toronto, d)the specific tariff rate, and e)the Canadian-American monetary exchange rate.

Each of these variables was first of all treated as independent in order to gain information on its influence on the volume of imports. Using weekly observations on each of these variables, the following statistical procedures were performed:

1. CORREL -- correlation analysis and the determination of means and standard deviations for each variable.
2. OLSQ and PLOTS -- ordinary least squares regression analysis with graphic plotting of the actual, predicted and residual values for each observation.
3. CORC and PLOTS — regression analysis using the Cochrane-Orcutt iterative technique and the plotting option.

This set of operations is referred to as an analytical sequence. The analytical sequences discussed in this chapter are numbered to facilitate reference to them. The code names for each variable used in the computer programme are employed throughout the presentation and discussion of results in this chapter as convenient abbreviations. The key to the codes for the variables used in the analysis of slaughter cattle trade is as follows:

1. CARCP -- the price of carcass beef in the Toronto market, in cents per pound.
2. PRSPR — the difference between the slaughter cattle price in Omaha and Toronto, in cents per pound.
3. SPTAR -- the specific tariff rate or tariff plus surcharge on Canadian imports of American slaughter cattle, in cents per pound.
4. TIME -- a trend variable.
5. VIMP -- the number of slaughter cattle imported by

Canada from the United States, in head per week.

6. XRATE -- the Canadian-American monetary exchange rate, in Canadian dollars per American dollar.

The results obtained from the first sequence were as follows:

Means and Standard Deviations

Variable	Mean	Standard Deviation
VIMP	1830.37	3489.95
PRSPR	-2.36	5.53
TIME	103.49	59.59
CARCP	65.60	9.97
SPTAR	1.35	0.77
XRATE	1.01	0.02

Correlation Matrix

	VIMP	PRSPR	TIME	CARCP	SPTAR	XRATE
VIMP	1.00					
PRSPR	-0.33	1.00				
TIME	0.37	-0.17	1.00			
CARCP	0.43	-0.22	0.87	1.00		
SPTAR	0.17	-0.42	-0.19	-0.30	1.00	
XRATE	-0.16	-0.01	-0.75	-0.43	0.08	1.00

Ordinary Least Squares Regression Analysis[1]

$$\text{VIMP} = -15881.74 - 60.82\ \text{PRSPR} - 1.47\ \text{TIME}$$

$$+183.96\ \text{CARCP}^{**} + 1264.44\ \text{SPTAR}^{**} + 3895.67\ \text{XRATE}$$

$$R^2 = 0.29$$

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[1] In the equations presented in each of the analytical sequences, a single asterisk (*) indicates significance of the coefficient at the 5 percent level, while two asterisks (**) indicate that the coefficient is significant at the 1 percent level (two-tailed test).

$$D.W. = 0.15 \text{ (positive)}^{1}$$

Cochrane-Orcutt Regression Analysis[2]

$$VIMP-0.95VIMP_{(-1)} = -16657.40 + 10.28\,(PRSPR-0.95PRSPR_{(-1)}) + 7.07\,(TIME-0.95TIME_{(-1)}) + 166.92\,(CARCP-0.95CARCP_{(-1)})^{**} + 98.40\,(SPTAR-0.95SPTAR_{(-1)}) + 6661.91\,(XRATE-0.95XRATE_{(-1)})$$

$$R^2 = 0.91$$

$$D.W. = 1.15 \text{ (positive)}$$

It can be seen from the correlation matrix that the trend variable (TIME) is highly correlated with both the Toronto beef carcass price (CARCP) and the Canadian-American monetary exchange rate (XRATE). There is no a priori reason for such a correlation, but it does suggest the presence of multicollinearity. The consequences of multicollinearity may be summarized as follows:

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[1] D.W. = Durbin-Watson statistic. The results of this test are indicated as follows: positive=positive autocorrelation indicated; inc.=inconclusive results; free=free from autocorrelation. The level of significance at which all Durbin-Watson statistics are evaluated is 1 percent unless otherwise indicated.

[2] In the description of the results of the Cochrane-Orcutt analysis in each of the analytical sequences in this chapter, the subscript minus one ($_{-1}$) is used to denote the time period immediately preceding the present one.

Statistic	**Effect**
1. a,bi (regression coefficients)	1. unbiased but unstable
2. Sa,Sbi (standard errors of regression coefficients)	2. unbiased but very large and unstable
3. R^2	3. unbiased

As the degree of correlation between the dependent variables increases, the ability to statistically distinguish their individual influences on the dependent variable is reduced. In the face of perfect multicollinearity it becomes impossible to make such a distinction and the matrix estimation method breaks down. The most advisable procedure for reducing multicollinearity, and the one suggested here, is the respecification of the regression model. In this case the trend variable may simply be dropped. Any secular trend in the volume of imports will largely be accounted for by one of the other two correlated variables.

Another reason for removing the trend variable instead of, for example, either the Toronto carcass price or the exchange rate is that the action of a simple trend variable is to account for some unexplained variation. Time, per se, does not bear economic impact but may be closely associated with variables such as population size or per capita income.

A trend variable can be used as a reasonable proxy for such variables but is not as satisfactory in actually explaining a situation as they would be. In the present case there is no theoretical reason that the volume of Canadian slaughter cattle imports would be correlated with any time related variable, therefore making the exclusion of the trend variable theoretically permissable.

The correlation matrix confirms two expectations. The correlation coefficient for the volume of imports (VIMP) and the price spread (PRSPR) are negative, as expected. Because the price spread was defined as the Omaha minus Toronto slaughter cattle price, it would be expected that as the Toronto price increased relative to Omaha, the volume of imports would increase and the price spread variable would move in a negative direction, thus giving a negative correlation between the two. The correlation coefficient between the volume of imports and the price of beef carcasses in Toronto would be expected to be positive. This would be the case since an increase in the demand for beef carcasses, signalled by an increase in their price, would cause an increase in the demand for slaughter cattle, a derived demand, and thus an increase in import volume. The correlation matrix confirms the expected positive sign.

There was no expectation regarding the absolute value of the correlation coefficients other than that the VIMP-

PRSPR coefficient might be higher than the others, due to the strong theoretical connection between the two. The actual results show a rather low value for all the coefficients including the ones for the volume of imports and the price spread.

The results of the ordinary least squares regression analysis would seem at first to indicate a causal relationship between the volume of slaughter cattle imports and the Toronto beef carcass price. The coefficient of the carcass price variable appears, from its t value, to be significantly different from zero at the 1 percent confidence level. Such a conclusion is weakened, however, by the presence of serious positive autocorrelation, as indicated by the very low value of the Durbin-Watson statistic. The consequences of autocorrelation, when lagged variables are not included in the analysis, can be summarized as follows:

Statistic	Effect	
1. a,bi (regression coefficients)	1. unbiased (consistent)	
2. Sa,Sbi (standard errors of regression coefficients)	2. biased	a)negative autocorrelation causes a positive bias b)positive autocorrelation causes a negative bias
3. R^2	3. biased	a)negative autocorrelation causes a negative bias b)positive autocorrelation causes a positive bias

The general result of autocorrelation is that while unbiased estimates of the regression coefficients are obtained, they are not minimum variance estimates. Furthermore, because the presence of positive autocorrelation imparts a negative bias to the estimates of the standard error of the coefficients, it also imparts a bias to statistics in which the standard error is utilized, such as the t statistic for testing the significance of the estimated coefficients. This situation may result in erroneous acceptance of a coefficient as being significant when, in fact, it is not. In any case, since minimum variance estimates of the coefficients are not being obtained, the t test becomes unreliable and its results inconclusive. Consequently, this is the conclusion drawn in the present case. While there appear to be significant relationships indicated, one is unable to evaluate their significance.[1]

The PLOTS function was operative in conjunction with this analytical sequence and its output indicated a poor predictive ability in the equation. This conclusion is confirmed by the low R^2 value (0.29), although this, again, is not a reliable test due to the presence of autocorrelation.

The analytical procedure utilizing the Cochrane-Orcutt iterative technique produced a rather high estimate of the rho value (0.95). This strong correlation between successive error terms indicates the presence of a cyclical pattern in the volume of Canadian slaughter cattle imports which was not being explained by the particular independent variables or the estimating equation being used. The high rho value also means that, in essence, the statistical procedure has calculated the difference between successive observations of each variable and used these first-difference values as the basis of the regression analysis.[1] The Cochrane-Orcutt technique is not able to add any new information to the statistical analysis. What it has done in this case, however, is to calculate the relationship between the change in each explanatory variable from one week to the next and the change in the volume of imports from week to week. It is attempting to determine, for example, the relationship between import volume and price spread on the basis of the week to week change in each. While the Cochrane-Orcutt technique is designed to produce reliable estimates of the true regression coeffcients, it deals with marginal differences in the variables rather than with absolute amounts. While this approach may still yield statistically reliable estimates of the desired coefficients, its essential difference from the ordinary least squares approach must be appreciated.

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[1] The exact function of the t test should be appreciated. When used to test the null hypothesis that an estimated coefficient in a regression equation is equal to zero, the t test may indicate that the null hypothesis should be rejected, but it will not indicate that the null hypothesis must be accepted. Lack of "statistical significance" does not prove that there is no relationship between the dependent and independent variables, but only that the relationship is weakly evident and indistinguishable from none at all. If there were a priori or theoretical reasons for expecting a relationship to exist, and the estimated coefficient indicated the presence of such a relationship, it would be unwise to reject such a conclusion on the basis of the t test. The insignificance of the estimated t value may be due to a small number of observations causing a high standard error.

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[1] If the value of rho had been 1.00 rather than 0.95, true first-differences would have been calculated. Rather than calculating the true change from one observation to the next, the programme, with the 0.95 value of rho, has calculated generalized differences and is slightly overstating increasing changes and slightly understating decreasing changes relative to true first differencing. The value of rho, however, is close enough to unity to consider the transformed data as true marginal changes.

The results of this analytical sequence are again qualified by the presence of positive autocorrelation. The numerical value of the calculated Durbin-Watson statistic has increased in this instance, but still indicates that positive autocorrelation is present.

The PLOTS function and its output provide a valuable tool at this point for evaluating the operation of the Cochrane-Orcutt regression analysis. Appendix 1 contains the plots of the actual and fitted values of the volume of Canadian imports of American slaughter cattle. This graph reveals a high degree of predictive accuracy, which is confirmed by the high R^2 value (0.91) shown in the analytical results. The plot shows, however, a one week discrepancy between the actual and predicted amounts of imports. The volume of imports of slaughter cattle estimated by the equation for any particular week corresponds closely, in most cases, to the actual volume of imports in the previous week. If the scale on which the predicted values are plotted were shifted one week to the left, the two lines would coincide in most places. There are two possible reasons for this discrepancy. It may be due either to some economic phenomenon within the market or to something within the computational procedure of the programme. The former reason is less likely since there is no a priori or theoretical connection between the volume of imports in a paricular week and import volume influencing factors in the following week. If the relationship were reversed, it would be possible to hypothesize a causal connection between factors such as the Canadian-American slaughter cattle price spread in one week and the volume of Canadian imports in the following week. It would not be possible, however, for factors such as the price spread in the present week to influence the volume of imports in the past week. The only logical economic conclusion from the results as they stand would be that the volume of slaughter cattle imported by Canada in a particular week influenced the Canadian-American price spread in the following week. It is more probable, however, that some feature within the computational procedure of the computer programme has shifted the estimates of slaughter cattle import volumes ahead one week. This conclusion is supported by the fact that, despite attempts to remove the one week discrepancy through lagging the dependent variable one week, the same one week discrepancy again appeared between the actual and predicted volume of imports of slaughter cattle.

The conclusion which can therefore be drawn from the analysis is that the results have underestimated the capacity of the model to explain the variance in the weekly volume of slaughter cattle imports. Had the one week discrepancy between actual and fitted values not been present, a higher R^2 value and possibly a higher Durbin-

Watson statistic would likely have been obtained. It would be expected, also, that the estimation error of the model would have been reduced, thus increasing the t values of the estimated coefficients. A final expectation is that the values of the estimated coefficients would not have been altered. There is ground for believing the present values are best estimates of the true coefficients.

Analytical Sequence 2

The next sequence in the analysis of Canadian slaughter cattle imports involved removal of two independent variables and reanalysis using the same statistical functions. The trend variable was removed for reasons discussed above. The exchange rate was used to transform the Omaha price of slaughter cattle from American to Canadian dollars. The exchange rate had been expressed as the Canadian price of an American dollar and could therefore be multiplied with the original Omaha price to change the latter into Canadian dollars. Using weekly observations again, the following operations were performed:

1. CORREL — correlation analysis and the determination of means and standard deviations for each variable.
2. OLSQ and PLOTS — ordinary least squares regression

analysis with graphic plotting of the actual, predicted and residual values for each observation.

3. CORC and PLOTS — regression analysis using the Cochrane-Orcutt iterative technique and the plotting function.

The results obtained from the second sequence were as follows:

Means and Standard Deviations

Variable	Mean	Standard Deviation
VIMP	1830.37	3489.95
PRSPR	48.35	416.86
CARCP	65.60	9.87
SPTAR	1.35	0.77

Correlation Matrix

	VIMP	PRSPR	CARCP	SPTAR
VIMP	1.00			
PRSPR	0.13	1.00		
CARCP	0.43	0.00	1.00	
SPTAR	0.17	0.02	-0.30	1.00

Ordinary Least Squares Regression Analysis

VIMP = 12310.21** +1.06 PRSPR* +184.46 CARCP**
+1467.44 SPTAR**

$R^2 = 0.30$

D.W. = 0.14 (positive)

Cochrane-Orcutt Regression Analysis

$$VIMP-0.95VIMP_{(-1)} = -9691.68^{**} + 0.63\,(PRSPR-0.95PRSPR_{(-1)})^{**} + 174.17\,(CARCP-0.95CARCP_{(-1)})^{**} + 95.55\,(SPTAR-0.95SPTAR_{(-1)})$$

$$R^2 = 0.92$$

$$D.W. = 1.16 \text{ (positive)}$$

The correlation matrix has been changed somewhat by the exclusion of the trend variable and by the redefinition of the price spread variable. One such change occurred in the VIMP-PRSPR coefficient which unexpectedly became positive. Since no a priori reason for such a change exists, it would have to be attributed to chance. One feature of the correlation matrix which did not change was the generally low value of the coefficients.

The results of both the ordinary least squares regression analysis and the Cochrane-Orcutt regression analysis did not change greatly from the previous runs. There was an apparent increase in the significance of some of the coefficients, but the presence of autocorrelation in both sequences again invalidates the t test and makes it impossible to draw conclusions about the significance of the coefficients. The estimated rho value is again 0.95, indicating the Cochrane-Orcutt sequence is again essentially working with the marginal change in variables from one week to the next.

The R^2 values in the two sequences are much the same as those calculated prior to the exclusion of the trend variable and the redefinition of the price spread variable. While the R^2 statistic is again unreliable, there appears to be substantially better predictive ability in the Cochrane-Orcutt sequence than in the ordinary least squares sequence. This is again confirmed by the plotting of actual, predicted and residual values. The PLOTS function again reveals a one week discrepancy between the actual and predicted volume of slaughter cattle imports. As in the first analytical sequence, the actual volume of imports preceeds the predicted amount. The discussion and conclusions* presented previously with regard to this phenomenon apply as well to the present sequence.

Analytical Sequence 3

A new hypothesis was taken as the basis of the next analytical sequence in attempting to explain Canadian slaughter cattle import volumes. It was that, rather than acting as a dynamic factor in governing import volumes, the tariff acts as a structural factor, one which contributes in a static sense to the nature of the North American cattle market. It was supposed therefore that when the tariff or surcharge level was changed, the responsiveness of imports to such factors as the Canadian-American price spread would be different. Consequently, the procedure followed was to divide the analytical period into blocks within which the tariff level remained unchanged. This was particularly easy because of the nature of tariff changes. Adjustments in the tariff rate tend to be made infrequently and in discrete jumps. The tariff blocks established in this way were as follows:

Block	Tariff	Period of Enforcement	Observation Numbers
	..... tariff rates in cents per pound		
1.	1.5	Jan.1,1970-Feb.20,1973	1 - 162
		Sept.22,1973-Nov.3,1973	194-200
2.	no tariff	Feb.20,1973-Sept.22,1973	162-194
3.	4.5	Nov.3,1973-Dec.31,1973	200-208

Because each block of observations was defined on the basis of a constant tariff, the tariff variable was dropped from this sequence. Having no variation within the individual periods, it would contribute no statistical information or predictive ability. On each of the blocks the following operations were carried out:

1. CORREL -- correlation analysis and the determination of means and standard deviations for each variable.
2. OLSQ -- ordinary least squares regression analysis.
3. CORC -- regression analysis with the Cochrane-Orcutt iterative technique.

The results obtained from the third sequence were as follows:

Block 1 -- Jan. 1, 1970 to Feb. 20, 1973 and Sept. 22, 1973 to Nov. 3, 1973.

Means and Standard Deviations

Variable	Mean	Standard Deviation
VIMP	1656.27	3499.24
PRSPR	59.39	459.74
CARCP	62.04	6.22

Correlation Matrix

	VIMP	PRSPR	CARCP
VIMP	1.00		
PRSPR	0.16	1.00	
CARCP	0.57	0.08	1.00

Ordinary Least Squares Regression Analysis

$$VIMP = -18024.84^{**} + 0.85\ PRSPR + 316.43\ CARCP^{**}$$

$$R^2 = 0.34$$

$$D.W. = 0.10\ (\text{positive})$$

Cochrane-Orcutt Regression Analysis

$$VIMP-VIMP_{(-1)} = -15470.63^{**} + 0.64\ (PRSPR-0.96PRSPR_{(-1)})^{**} + 268.67\ (CARCP-0.96CARCP_{(-1)})^{**}$$

$$R^2 = 0.93$$

$$D.W. = 1.12\ (\text{positive})$$

Block 2 -- Feb. 20, 1973 to Sept. 22, 1973.

Means and Standard Deviations

Variable	Mean	Standard Deviation
VIMP	1893.82	3013.29
PRSPR	-1.31	2.68
CARCP	81.48	7.87

Correlation Matrix

	VIMP	PRSPR	CARCP
VIMP	1.00		
PRSPR	-0.36	1.00	
CARCP	0.50	-0.30	1.00

Ordinary Least Squares Regression Analysis

$$VIMP = -11828.14^{*} - 254.83\ PRSPR + 165.53\ CARCP^{**}$$

$$R^2 = 0.30$$

$$D.W. = 0.30\ (\text{positive})$$

Cochrane-Orcutt Regression Analysis

$$VIMP-0.98VIMP_{(-1)} = 715.86 + 48.36\ (PRSPR-0.98PRSPR_{(-1)}) + 139.55\ (CARCP-0.98CARCP_{(-1)})$$

$$R^2 = 0.85$$

$$D.W. = 1.16\ (\text{positive})$$

Block 3 — Nov. 3, 1973 to Dec. 31, 1973.

Means and Standard Deviations

Variable	Mean	Standard Deviation
VIMP	8092.29	2780.88
PRSPR	-7.21	1.49
CARCP	82.55	1.23

Correlation Matrix

	VIMP	PRSPR	CARCP
VIMP	1.00		
PRSPR	0.20	1.00	
CARCP	0.32	0.89	1.00

Ordinary Least Squares Regression Analysis

$$VIMP = 122530.65 - 745.94\ PRSPR + 1517.35\ CARCP$$

$$R^2 = 0.13$$

$$D.W. = 1.08\ (\text{positive})$$

Cochrane-Orcutt Regression Analysis

$$VIMP-0.67VIMP_{(-1)} = -28037.84 - 981.46\ (PRSPR-0.67PRSPR_{(-1)}) + 310.29\ (CARCP-0.67CARCP_{(-1)})$$

$$R^2 = 0.61$$

$$D.W. = 2.93\ (\text{free})$$

The correlation coefficients in the three blocks show a rather varied degree of association between the three variables, ranging from 0.08 to 0.89. The volume of imports would be expected to bear a negative and significant degree of correlation toward the Canadian-American slaughter cattle price spread, and a positive and possibly less significant relationship toward the Toronto beef carcass price. The results obtained in this sequence confirm the expectations regarding the VIMP-CARCP coefficient, but in Blocks 1 and 3 the VIMP-PRSPR coefficient has an unexpected positive sign.

With regard to the question of multicollinearity, it appears to be somewhat more serious in this sequence. The PRSPR-CARCP correlation coefficient is significant at the 1 percent level, the standard error values for the estimated regression coefficients are large for both PRSPR and CARCP, and there is more than 50 percent correlation between the variables. The conclusion may be drawn, therefore, that the degree of multicollinearity is fairly high, with the consequence that the estimated regression coefficients should be considered unstable and the t tests for their significance should be taken as somewhat unreliable due to the high standard error values.

The regression analysis results in this sequence are also varied. The ordinary least squares analysis estimates of the price spread coefficients are +0.85, -254.83 and -745.94 in Blocks 1 to 3, respectively. While none of these have significant t values, the latter two are in accordance with expectations, while the first has an unexpected sign and appears to be of negligible size. The ordinary least squares estimates of the carcass price coefficients are +316.43, +165.53 and +1517.35 for Blocks 1 to 3, respectively. While the last one has an insignificant t value, this may be due to a very small sample size. These coefficients would indicate an increase in Canadian imports of slaughter cattle in response to an increase in the Toronto beef carcass price, a result which would be expected.

The results of the Cochrane-Orcutt analysis must be interpreted with care. What is in fact being estimated is the responsiveness of the change in imports to changes in the price spread or carcass price. While these coefficients are taken as statistically reliable estimates of the relationships of the respective absolute amounts, their exact nature should be appreciated. The estimated price spread coefficients are +0.64, +48.36 and -981.46 for Blocks 1 to 3, respectively. The last of these, while bearing an insignificant t value, is the most logical in appearance. It would indicate a 981 head per week increase in Canadian imports of slaughter cattle (or in the weekly marginal change in imports) in response to a one dollar increase in the Toronto slaughter cattle price relative to the Omaha price (or in the weekly marginal change in this spread). The coefficients of the carcass price variable estimated from the Cochrane-Orcutt procedure are +268.67, +139.55 and +310.29 for Blocks 1 to 3, respectively. These are all fairly consistent and similar to expectations.

The presence of autocorrelation in all but the third block of the Cochrane-Orcutt analysis again subjects the results to some uncertainty. While the estimates are unbiased, they are not minimum variance and the R^2 and t statistics are therefore unreliable. It should be recalled, however, that detection of a relationship between the dependent and independent variables is not contingent on statistical significance. An insignificant t value does not necessarily mean that there is no economic relationship indicated, but rather that these relationships may be indistinguishable from zero. It would be safe to reject the hypothesis of a real relationship between two variables if none were theoretically expected or statistically indicated.

The primary objective of this analytical sequence was to test for significant differences between the coefficients derived from the analysis of the three blocks. This procedure would indicate whether the presence or level of the tariff altered the way in which import volumes of slaughter cattle responded to independent factors such as the price spread and the price of carcass beef in the importing country. The testing procedure involves each pair of coefficients ($p_1 - p_2$, $p_1 - p_3$, $p_2 - p_3$, $c_1 - c_2$, $c_1 - c_3$, $c_2 - c_3$, where "p" refers to the estimated coefficients of the price spread variable, "c" refers to the estimated coefficients of the carcass price variable, and the subscript numbers refer to the block numbers). The coefficients of the ordinary least squares analysis and the Cochrane-Orcutt procedure are listed in Table 5 for comparison. They will be tested sparately and the results compared.

TABLE 5

ANALYTICAL SEQUENCE 3 — ESTIMATED REGRESSION COEFFICIENTS

	OLSQ	CORC
p_1	0.85	0.64
p_2	−254.83	48.36
p_3	−745.94	−981.46
c_1	316.43	268.67
c_2	165.53	139.55
c_3	1517.35	310.29

The test of significance of the difference between coefficients involves the Z - statistic. The calculated Z - values are shown in Table 6.

TABLE 6

ANALYTICAL SEQUENCE 3 — Z - VALUES FOR PAIRS OF REGRESSION COEFFICIENTS

	OLSQ	CORC
$p_1 - p_2$	8.147**	2.978**
$p_1 - p_3$	1.047	3.257**
$p_2 - p_3$	0.688	3.410**
$c_1 - c_2$	13.648**	8.521**
$c_1 - c_3$	1.390	0.126
$c_2 - c_3$	1.565	0.519

Note: (**) indicates statistically significant difference at the 1% confidence level.

These results are somewhat difficult to interpret. They indicate a different responsiveness of slaughter cattle imports to both the Canadian-American price spread and the Toronto beef carcass price in Blocks 1 and 2 in this analysis. This might be attributed to the 1.5 cents per pound tariff which distinguished Blocks 1 and 2.

There are, however, a number of weaknesses in this argument. First, and perhaps most important, this analytical method does not provide conclusive proof that it was the change in the tariff which caused the alteration in estimated coefficients. If there was reason to believe that such a tariff change was the only significant difference between market conditions in the two blocks, it might be permissible to attribute the change in coefficients to the change in the tariff. In a market as complex, however, as the North American cattle market, such a conclusion would be extremely tenuous. This statement is supported by the present results. There appears to be a significant difference between all the coefficients in Blocks 1 and 2 which might, as stated, be attributed to the addition of the tariff. It would be expected, however, that an even more pronounced difference would be observable between the coefficients of Blocks 2 and 3, blocks which were distinguished by the presence of both the tariff of 1.5 cents per pound and a surcharge of 3 cents per pound. Except in the comparison of the price spread coefficients estimated by the Cochrane-Orcutt analysis, there was no significant difference between the coefficients estimated for Blocks 2 and 3.

A possible explanation of the results of the present analysis is the presence of autocorrelation in the estimation of the coefficients. As discussed previously, autocorrelation results in coefficient estimates which are not "minimum variance". Unduly large standard errors of estimation of the coefficients lead to unduly large standard errors of the difference in estimating the Z values and thus to unduly small Z-values. The Z-test is therefore invalid.

Two points can be made in concluding the discussion of this analytical sequence. The first is that when autocorrelation invalidates the Z-test of the significance of the difference between two comparable coefficients, the only recourse appears to be to judge the significance of the difference "by eye". It would seem, from the present results, that the Canadian-American price spread coefficients were, indeed, distinctly different in each block, but that the coefficients of the Toronto carcass price variable were not significantly different.

The second point that can be made is that without some theoretical or a priori reason for attributing differences in coefficients to the level of the tariff or surcharge, it would be unwise to do so. It does not appear that such theoretical backing exists. While it might be concluded that the level of the tariff or surcharge affected the responsiveness of Canadian slaughter cattle imports to the Canadian-American price spread and did not affect its responsiveness to the Toronto beef carcass price, such a conclusion would have to stand with the support of evidence rather than proof.

Analytical Sequence 4

The hypothesis on which this analytical sequence was based was that there are numerous unidentified short term lags and other influences operating in the North American slaughter cattle market. These might include buying patterns in which orders placed by a Canadian firm with its American agent would not be filled for a few days, or inventory patterns which might give a short term cycle to buying patterns. These, it was believed, cause distortion of the results when a short observational frequency such as a week is employed. In order to avoid such short term distortions, average weekly values per month were calculated for each variable by dividing monthly totals by the appropriate number of weeks. No other data transformations were performed, the definition of variables was the same as in the first three analytical sequences, and "tariff blocks" were not defined or employed. The following operations were performed:

1. CORREL -- correlation analysis and the determination of means and standard deviations for each variable.

2. OLSQ -- ordinary least squares regression analysis.

3. CORC -- regression analysis using the Cochrane-Orcutt iterative technique.

The results obtained from the fourth sequence were as follows:

Means and Standard Deviations

Variable	Mean	Standard Deviation
VIMP	1858.54	3425.80
PRSPR	-1.57	1.80
CARCP	65.73	10.08
SPTAR	1.38	0.78

Correlation Matrix

	VIMP	PRSPR	CARCP	SPTAR
VIMP	1.00			
PRSPR	-0.66	1.00		
CARCP	0.46	-0.45	1.00	
SPTAR	0.24	-0.46	-0.24	1.00

Ordinary Least Squares Regression Analysis

$$VIMP = -5239.63 - 1012.23\ PRSPR^{**} + 79.31\ CARCP$$
$$+\ 212.91\ SPTAR$$

$$R^2 = 0.47$$

$$D.W. = 1.21\ (\text{positive})$$

Cochrane-Orcutt Regression Analysis

$$VIMP - 0.55VIMP_{(-1)} = -3576.53 - 653.56\ (PRSPR-$$
$$0.55PRSPR_{(-1)})^{*} + 74.01\ (CARCP - 0.55CARCP_{(-1)}) -$$
$$330.01\ (SPTAR - 0.55SPTAR_{(-1)})$$

$$R^2 = 0.58$$

$$D.W. = 1.59\ (\text{free})$$

The correlation matrix presents partial correlation coefficients which may, as in analytical sequence 1, indicate the presence of multicollinearity. The PRSPR-CARCP coefficient of -0.45 and the PRSPR-SPTAR coefficint of -0.46 show a degree of inverse correlation though to a smaller extent than was present in the first analytical sequence. While there are no straightforward statistical tests for multicollinearity, there are a number of bases on which to judge if it is present to a serious degree. It is possible, first, to test the significance of the correlation coefficients; in this case both of the coefficients in question prove to be significantly different from zero at the 1 percent confidence level. This, however, does not prove that the multicollinearity in the present situation is serious -- it simply proves that there is correlation of the variables involved. Another approach is to examine the size of the standard error of the coefficients. In this case only SPTAR has a standard error larger than the estimated coefficient itself (653.64 compared to 212.91), an inconclusive indication of serious multicollinearity. A third method of evaluation is simply to give a value judgement on the apparent degree of multicollinearity. In the present case, since less than 50 percent correlation is indicated between the estimated regression coefficients, the matter will not be pursued further.

The averaging procedure used in this sequence appears to be fairly successful in dealing with Canadian imports of slaughter cattle. The results obtained in this analytical sequence are more in line with expectations than any previously obtained. As stated already, expectations regarding the sign and order of magnitude of the estimated coefficients are based on theoretical reasons and a priori knowledge of the market. Such expectations are therefore regarded as important tests of the analytical results. When the derived and expected results do not approximately coincide, the procedure followed has been to seek a reasonable explanation for the divergence and to examine other analytical appoaches.

The coefficients estimated by the present analytical sequence appear to coincide particularly closely with expected results. Both of the estimated coefficients for the price spread variable bear a negative sign, indicating an increase in the volume of slaughter cattle imports in response to an increase in the Toronto slaughter cattle price relative to the Omaha price. The ordinary least squares estimate of the price spread coefficient indicates that for a one dollar increase in the Toronto price relative to the Omaha price, there would be a 1,012 head per week increase in Canadian slaughter cattle imports. The Cochrane-Orcutt analysis estimate sets this figure at 654 head per week.[1] The two estimates of the beef carcass price coefficient are very similar and indicate an increase of 74 to 79 head per week in Canadian slaughter cattle imports in response to a one dollar increase in the Toronto carcass price. The estimated coefficients for the tariff variable are very different from each other and have very low significance levels. Due to the fact that the monthly average tariff rate underwent relatively few changes during the four year period, there may not have been sufficient evidence for estimating the true effect of the tariff.

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[1] The rho value estimated in this sequence is 0.55, a lower value than previously obtained. The analytical procedure is therefore not dealing with a close approximation of first differences, but rather with a more generalized relationship between sequential observations. The implication of this in interpreting the analytical results is that the programme is not strictly dealing with the change in factors from one week to the next, but rather with weekly observations modified by the immediately previous observation. While the price spread coefficient of 654 is not strictly comparable to the value of 1,012 estimated by the ordinary least squares method, such a comparison is more valid than it would have been if the estimated rho value were higher.

Table 7 presents the elasticity values calculated for each variable at its mean value.

TABLE 7

ANALYTICAL SEQUENCE 4 — ELASTICITY COEFFICIENTS

ESTIMATED AT MEAN VALUES

	OLSQ	CORC
PRSPR	0.86	0.56
CARCP	2.80	2.57
SPTAR	0.16	-0.24

These results are also in accordance with expectations. The elasticity values for the PRSPR variable have a positive sign because of the negative mean value for the price spread observations.[1] The results show an inelastic response of import volume to the price spread and an elastic response of import volume to the domestic carcass price.

A possible conclusion at this point is that the methodology adopted in this analysis is not suitable for investigating the tariff as a separate factor influencing import volumes. Successful regression analysis is dependent on changes in the independent variables being approximately as frequent as variations in the dependent variable. In the case of Canadian slaughter cattle imports during the period 1970 to 1973, there were three changes in tariff and surcharge rates as compared with approximately 207 changes in the Canadian-American slaughter cattle price spead. In the case of other commodities or other observational periods there may not be any changes in the tariff rate, in which case it would be impossible to analyse the tariff as a separate independent variable by means of regression analysis. It appears then that the analysis of the effect of the tariff on the volume of trade would proceed most successfully by employing the methodology of Officer and Hurtubise,[1] or by utilizing the assumption that the price spread and tariff effects are the same.

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[1] The equation for the elasticity of the price spread variable is:
Elasticity = (d VIMP/d PRSPR)(mean PRSPR/mean VIMP)
The signs were: (–) [(–)/(+)] = (+)

While the "tariff elasticity of demand" has been calculated and presented in Table 7, it is not regarded as an accurate estimation of the true effect of the tariff. The reasons for this have been discussed above. An alternative method of determining the effect of the tariff is to equate its function with that of the price spread.

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[1] Officer and Hurtubise, "Price Effects."

The working concept on which the present analysis is based is that of a North American market operating in accordance with the principle of spatial equilibrium. Within such a market the maximum sustainable price differential between any two points is determined by the barriers to trade between them. In the case of cattle trade between Canada and the United States, these barriers are the cost of transportation and transfer plus the tariff and any surcharges plus non-tariff barriers. The assumption has been made that transportation and transfer costs have remained constant during the four years under consideration. They are therefore excluded from the regression analysis. If the tariff and surcharge rate has also varied too little to be successfully analysed by the regression technique, it should also be dropped from the list of independent variables. It is realized, however, that the tariff does, or potentially could, have an effect on the volume of trade, and it is specifically this effect for which a quantitative measurement is sought. Since the tariff is a true price instrument and does not exercise any effect on the volume of imports independent of the price spread, it can be stated that the tariff effect is part of the price effect. If the price spread variable was to be defined as before, _minus_ the tariff,[1] the estimated regression coefficient and elasticity would apply to both the tariff and the price spread variable. This is the approach taken in the next and final analytical sequence on Canadian slaughter cattle imports.

Analytical Sequence 5

In the final analytical sequence in the examination of slaughter cattle imports, the price variable was defined as the Canadian-American slaughter cattle price spread, in cents per pound, minus the Canadian tariff rate, also in cents per pound. Average weekly values per month for each variable were again used. In this sequence the following operations were performed:

1. CORREL -- correlation analysis and the determination of means and standard deviations for each variable.
2. OLSQ and PLOTS — ordinary least squares regression analysis with graphic plotting of predicted, actual and residual values for each observation.

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[1] The suggested definition of the price spread variable is: Price Spread = [(Omaha slaughter cattle price)(Canadian-American exchange rate)] - (Toronto slaughter cattle price) - (Canadian tariff on slaughter cattle).

3. CORC and PLOTS — regression analysis using the Cochrane-Orcutt iterative technique and the plotting option.

The results obtained from the fifth sequence were as follows:

Means and Standard Deviations

Variable	Mean	Standard Deviation
VIMP	1858.54	3425.80
PRSPR	-2.95	2.28
CARCP	62.73	10.08

Correlation Matrix

	VIMP	PRSPR	CARCP
VIMP	1.00		
PRSPR	-0.61	1.00	
CARCP	0.46	-0.27	1.00

Ordinary Least Squares Regression Analysis

VIMP = -7568.47** - 781.38 PRSPR**

+ 108.32 CARCP**

$R^2 = 0.46$

D.W. = 1.17 (positive)

Cochrane-Orcutt Regression Analysis

$$VIMP-0.51VIMP_{(-1)} = -5863.96 - 481.50\ (PRSPR-0.51PRSPR_{(-1)})^{*} + 95.40\ (CARCP-0.51CARCP_{(-1)})$$

$$R^2 = 0.56$$

$$D.W. = 1.56\ (\text{free})$$

Table 8 presents elasticity coefficients which have been calculated for each variable at its mean.

TABLE 8

ANALYTICAL SEQUENCE 5 — ELASTICITY COEFFICIENTS ESTIMATED AT MEAN VALUES

	OLSQ	CORC	Average
PRSPR	1.24	0.76	1.00
CARCP	3.83	3.32	3.57

As expected, the results of this analytical sequence are very similar to those of the previous one. The operation of removing the tariff from the list of independent variables and including it in the price spread term by subtracting it from the formerly defined price spread did not incorporate any new economic information into this sequence but simply recombined the existing data. Significant changes in the R^2 values were therefore not expected. To a large extent the discussion of the results of the previous sequence apply to the results obtained from the present one. Appendix 1 presents the plot of actual and predicted values from the Cochrane-Orcutt analysis of this sequence.

The removal of the independent tariff variable and the redefinition of the price term caused an increase in the calculated elasticity coefficients. The elasticity coefficient of the price spread variable, calculated from the ordinary least squares results, increased from the range of inelasticity to that of elasticity. The other three elasticity coefficients increased but did not undergo significant changes.

There does not appear to be any inherently correct way of deciding whether the pair of elasticity coefficients calculated from the ordinary least squares results or those calculated from the Cochrane-Orcutt results should be choosen as the "correct" ones. Lacking an a priori basis for selecting one pair or the other, it was decided to utilize simple averages. The average price spread (and tariff) elasticity of demand was exactly 1.00, and the average elasticity of the Toronto beef carcass price variable was 3.57. From these and the previous regression results, the following summary can be drawn:

Cause	Effect
1. A $1.00 increase in the Toronto slaughter cattle price relative to the Omaha price.	1. An increase of from 482 to 781 head per week in Canadian imports of American slaughter cattle
2. A 1.0% increase in the price spread between the Toronto and Omaha markets (caused by an increase in the Toronto price relative to the Omaha price).	2. A 1.0% increase in weekly imports of American slaughter cattle.
3. A $1.00 increase in the Toronto beef carcass price.	3. An increase of from 95 to 108 head per week in Canadian imports of American slaughter cattle.
4. A 1.0% increase in the Toronto beef carcass price.	4. A 3.57% increase in the weekly volume of Canadian imports of American slaughter cattle.

In accordance with the discussion of the preceding analytical sequence, the elasticity coefficient of the price variable may be taken as applicable to the responsiveness of the volume of Canadian imports of slaughter cattle to the Canadian-American price spread. Also, since the price spread is defined inclusive of the tariff, this elasticity coefficient may also be regarded as the "tariff elasticity of demand for imported slaughter cattle".

United States Feeder Cattle Imports

Analytical Sequence 6

The second major area of analysis in this study dealt with Canadian exports of feeder cattle to the United States. This analysis was introduced in the last chapter. The variables utilized in the intitial investigation of Canadian exports of feeder cattle were: a)the Canadian-American price spread for feeder cattle (Canadian average minus Kansas City), and b) the ratio of American cattle feed costs to the slaughter cattle price at Omaha. Both prices in (b) are in cents per pound and the resulting ratio is a quotient free of units. The dependent variable was the weekly volume of Canadian feeder cattle exports to the United States. The price spread variable is essentially the same as that used in the examination of slaughter cattle imports. It is defined as the average of feeder prices at Edmonton, Calgary and Winnipeg minus the feeder price at Kansas City. This definition means that the expected sign of the estimated coefficient will again be negative, as in the slaughter cattle import analysis. The ratio of U.S. cattle feed costs to slaughter cattle price is an indicator of demand for the more processed product. The demand for feeders is theoretically related to the profitability of feeding cattle.

Using weekly observations on the volume of feeder exports, the Canadian-American price ratio and the American feed cost - slaughter price ratio, the following statistical procedures were performed:

1. CORREL -- calculation of means, standard deviations and correlation coefficients.
2. OLSQ and PLOTS -- ordinary least squares regression analysis with graphic plotting of predicted, actual and residual values.
3. CORC and PLOTS -- regression analysis with the Cochrane-Orcutt iterative technique and the plotting function.

As with the discussion of the analysis of slaughter cattle imports, the code names for each variable used in the computer programme are used here as a convenient abbreviation. The key to these codes is as follows:

1. FCX -- The volume of feeder cattle exports from Canada to the United States, in head per week.
2. PRSPR -- the difference between the average feeder cattle price in Edmonton, Calgary and Winnipeg and the feeder cattle price at Kansas City, in cents per pound.
3. FDRTO -- the ratio of the American price of cattle feed to the price of slaughter cattle at Omaha.

The results obtained from the sixth sequence were as follows:

Means and Standard Deviations

Variable	Mean	Standard Deviation
FCX	942.99	1667.79
PRSPR	2.01	2.92
FDRTO	0.16	0.02

Correlation Matrix

	FCX	PRSPR	FDRTO
FCX	1.00		
PRSPR	0.005	1.00	
FDRTO	0.02	0.49	1.00

Ordinary Least Squares Regression Analysis

$$FCX = 650.31 - 3.44\ PRSPR + 1900.07\ FDRTO$$

$$R^2 = 0.0004$$

$$D.W. = 0.31 \text{ (positive)}$$

Cochrane-Orcutt Regression Analysis

$$FCX-0.85FCX_{(-1)} = 888.88 - 68.15\,(PRSPR-0.85PRSPR_{(-1)}) + 1402.30\,(FDRTO-0.85FDRTO_{(-1)})$$

$$R^2 = 0.72$$

$$D.W. = 2.11 \text{ (free)}$$

Table 9 shows the elasticity coefficients for the two variables, calculated from the results of the Cochrane-Orcutt analysis and calculated at the mean values of the variables.

TABLE 9

ANALYTICAL SEQUENCE 6 — ELASTICITY COEFFICIENTS ESTIMATED AT MEAN VALUES

PRSPR	-0.15
FDRTO	0.23

The estimated correlation coefficients show a very small degree of association between the volume of Canadian feeder cattle exports and either the Canadian-American price spread or the American "feeding ratio". The higher value for the PRSPR-FDRTO coefficient may be due to correlation between the price of feeders at Kansas City and the price of slaughter cattle at Omaha. The question of multicollinearity is again raised by this partial correlation coefficient. A test of significance shows it to be significant at the 1 percent level; the standard error values for both the PRSPR and FDRTO are fairly high (45.86 and 6949.91, respectively). There is, however, less than 50 percent correlation between the variables, leading to the conclusion that while multicollinearity was moderately serious, it was likely not serious enough to adversely affect the conclusions which might be drawn from this sequence.

From the correlation results it would be expected that the degree of statistically significant explanation achieved by the ordinary least squares regression analysis would be small. This, in fact, is the case. The two coefficients have t values which show almost no detectable difference from zero, the R^2 value is almost equal to zero and the Durbin-Watson statistic indicates a high degree of autocorrelation. The presence of such autocorrelation may explain the extremely low t and R^2 values.

The results of the Cochrane-Orcutt analysis are statistically greatly improved. The Durbin-Watson statistic indicates freedom from autocorrelation and thus reliable t and R^2 statistics. While the t statistics indicate that none of the regression coefficients are significant at the 5 percent confidence level, the coefficients themselves have moved toward the expected levels. The price spread coefficient bears the expected negative sign and has increased from -3.44 to -68.15. It is to be expected that a one dollar increase in the Kansas City feeder price relative to the Canadian average would increase feeder exports by at least 68 head per week. The estimated coefficient for the feeding ratio variable is, however, unexpected. The variable is defined as the American price of cattle feed divided by the Omaha slaughter cattle price. An increasing value for this ratio would indicate decreasing profitability of feeding cattle, and would therefore be associated with decreasing imports of Canadian feeder cattle. The estimated coefficient, however, bears a positive sign and is unexpectedly large. One explanation of the estimated size of the FDRTO coefficient may be that the variable has been inappropriately defined. The mean value of the ratio of cattle feed to slaughter cattle price is only 0.16, while that of weekly export volume of Canadian feeder cattle is 943. Had these values been of more similar magnitude, the estimated coefficient would have been much smaller. Perhaps the most significant result of this analytical sequence is the plot of actual and predicted values from the Cochrane-Orcutt analysis (see Appendix 1). This plot, similar to that of Analytical Sequence 1, shows a close correspondence between the actual and predicted values of feeder cattle exports, except for the uniform one week discrepancy between these two values. As with the slaughter cattle analysis, the actual values precede the predicted ones by one week. Removal of this one week discrepancy would likely improve the statistical results by removing a portion of the residual.

Analytical Sequence 7

In the second analytical sequence in the examination of Canadian feeder cattle exports, the hypothesis tested was that the volume of exports was determined by a weighted distribution of lagged price spreads from the present and three preceding weeks. The PRSPR variable was defined as:

$$PRSPR' = 0.4PRSPR + 0.3PRSPR_{(-1)} + 0.2PRSPR_{(-2)} + 0.1PRSPR_{(-3)}$$

The weights used were arbitrarily defined. In this sequence the "feeding ratio" was defined as before and the following operations were performed:

1. CORREL — calculation of means, standard deviations and correlation coefficients.
2. OLSQ -- ordinary least squares regression analysis.
3. CORC -- regression analysis with the Cochrane-Orcutt iterative technique.

The results obtained from the seventh sequence were as follows:

Means and Standard Deviations

Variable	Mean	Standard Deviation
FCX	942.99	1667.79
PRSPR'	1.95	2.73
FDRTO	0.16	0.02

Correlation Matrix

	FCX	PRSPR'	FDRTO
FCX	1.00		
PRSPR'	0.01	1.00	
FDRTO	0.02	0.47	1.00

Ordinary Least Squares Regression Analysis

$$FCX = 681.61 - 0.26\ PRSPR' + 1660.76\ FDRTO$$

$$R^2 = 0.0004$$

$$D.W. = 0.31\ (\text{positive})$$

Cochrane-Orcutt Regression Analysis

$$\mathrm{FCX}-0.85\mathrm{FCX}_{(-1)} = 978.21 - 113.17\,(\mathrm{PRSPR}'-$$

$$0.85\mathrm{PRSPR}''_{(-1)}) + 1494.62\,(\mathrm{FDRTO}-0.85\mathrm{FDRTO}_{(-1)})$$

$$R^2 = 0.72$$

$$\mathrm{D.W.} = 2.11\ (\mathrm{free})$$

The results of this analytical sequence are very similar to those of the previous one. The correlation coefficients are almost identical, the estimated regression coefficients are very close in value and identical in sign, the t, R^2, Durbin-Watson and rho statistics are much the same or identical.[1] The estimated coefficients of elasticity, calculated from the Cochrane-Orcutt results at the means of the variables, are shown in Table 10.

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[1] The conclusion with regard to multicollinearity can be the same as in the previous sequence.

TABLE 10

ANALYTICAL SEQUENCE 7 — ELASTICITY COEFFICIENTS ESTIMATED AT MEAN VALUES

PRSPR'	-0.23
FDRTO	0.25

The distributed lag of the price spread variable appears to have slightly altered the elasticity coefficient for the price spread variable, and has left the elasticity coefficent for the feeding ratio variable almost unchanged.

The conclusion which may be drawn from this analytical sequence is that the use of a four week distributed lag pattern on the price spread variable does not change the results appreciably. The volume of Canadian feeder cattle exports does not seem to depend any more or less on the price spread over the past three weeks than it does on the present week. This, in turn, would indicate a degree of serial correlation in the price spread observations which is not unexpected. If the price spread observations were completely random, the volume of exports might depend either more or less on a distributed lag pattern than on the single observation of the present week's price spread; it is unlikely that the volume of exports would depend to the same extent on the distributed lag and the single observation if the observations of price spread were randomly distributed.

Analytical Sequence 8

The final analytical sequence investigated the use of monthly averages of weekly observations on feeder cattle exports. In the fourth and fifth analytical sequences this technique lowered the R^2 value of the esitmation but improved the statistical significance of the coefficient of the price spread variable. For theoretical reasons this variable was expected to be the most important determinant of slaughter cattle imports. The same reasoning is used in the present sequence. The object of the sequence is to improve the statistical significance of the estimated price spread coefficient and to observe the corresponding changes in the R^2 and Durbin-Watson statistics. As before, all variables are transformed by taking monthly averages. The following analytical procedures were performed on the data:

1. CORREL — correlation analysis with calculation of means and standard deviations for each variable.
2. OLSQ and PLOTS — ordinary least squares regression analysis with plotting of actual, predicted and residual values.
3. CORC and PLOTS — regression analysis with the Cochrane-Orcutt iterative technique and use of the

plotting function.

The results obtained from the eighth sequence were as follows:

Means and Standard Deviations

Variable	Mean	Standard Deviation
FCX*	941.01	1569.63
PRSPR	2.12	3.01
FDRTO	0.16	0.02

Correlation Matrix

	FCX	PRSPR	FDRTO
FCX	1.00		
PRSPR	0.004	1.00	
FDRTO	−0.01	0.67	1.00

Ordinary Least Squares Regression Analysis

$$FCX = 1340.42 + 11.21\ PRSPR - 2667.07\ FDRTO$$

$$R^2 = 0.0004$$

D.W. = 0.89 (positive)

Cochrane-Orcutt Regression Analysis

$$FCX-0.58FCX_{(-1)} = 1971.03 - 78.71\,(PRSPR-0.58PRSPR_{(-1)}) - 5111.55\,(FDRTO-0.58FDRTO_{(-1)})$$

$$R^2 = 0.32$$

$$D.W. = 2.02 \text{ (free)}$$

The elasticity coefficients calculated from the Cochrane-Orcutt results were -0.17 for the price spread variable and -0.84 for the feeding ratio variable.

The results of this sequence may be compared with those of the sixth and seventh analytical sequences, discussed above. The correlation coefficients are similar to those obtained earlier, with the exception of the FCX-FDRTO coefficient which now bears a negative sign. The volume of Canadian feeder cattle exports still has a low degree of association with the two independent variables.

With regard to the question of multicollinearity, it appears to be somewhat more serious in this sequence. The PRSPR-FDRTO correlation coefficient is significant at the 1 percent level, the standard error values for the estimated regression coefficients are large for both PRSPR and FDRTO (104.26 and 19964.67, respectively) and there is more than 50 percent correlation between the variables. The conclusion may be drawn, therefore, that the degree of multicollinearity is fairly high, with the consequence that the estimated regression coefficients should be considered unstable and the t tests for their significance should be taken as somewhat unreliable due to the high standard error value.

The results of the ordinary least squares analysis are also similar to those obtained in the previous sequences. There is an extremely low R^2 value, the t statistics indicate insignificant coefficient estimates, and the Durbin-Watson statistic indicates strong positive autocorrelation. It is not advisable to pursue a discussion of results of this nature.

The results of the Cochrane-Orcutt analysis bear less similarity to those of the previous two sequences than do the correlation and ordinary least squares results. While the Durbin-Watson statistic again indicates freedom from autocorrelation, the R^2 statistic is only 0.32 in this sequence (as compared with 0.72 in the previous two sequences). The significance of the price spread coefficient, rather than increasing as expected, has been further reduced. The coefficient of the feeding ratio variable, while attaining the expected sign, has become less significant as well.

Appendix 1 presents the plots of actual and predicted values from the Cochrane-Orcutt analysis of this sequence.

A comparison of the plots of the results of Sequences 6 and 8 illustrates the higher degree of accuracy attained by the former. It is apparent that the use of the technique of monthly averaging has reduced rather than improved the predictive accuracy of the model.

In the case of Canadian exports of feeder cattle, it has not been possible to demonstrate a statistically significant relationship between the volume of exports and the price spread for feeders between the Canadian and American markets. While the lack of statistical significance in the estimated coefficients does not conclusively demonstrate that such a relationship does not exist, it does indicate that the methodology of the present analysis has not been suitable for establishing the existence of a real relationship. This conclusion is dependent, of course, on the level of significance involved. The coefficient estimated by the present analysis is significant at the 78 percent level. It may be concluded, therefore, that due to theoretical expectations, demonstrations in other studies and a weak statistical proof in the present study, there is a relationship between feeder cattle exports and the Canadian-American price spread. This relationship is one in which the price spread elasticity of demand for exports is -0.15 to -0.23; in other words, an inelastic demand. The inclusion of the feeding ratio variable in the model has some theoretical basis, but since the relationship is not one which appears to have been demonstrated in other studies, and since its statistical demonstration in the present study is very weak, such a relationship may be concluded to be of doubtful validity.

In the study of Kulshreshtha and Wilson,[1] the deflated farm price of cattle in Canada was included as an independent variable and was shown to have a significant effect on the annual volume of Canadian feeder steer exports. The elasticity of feeder exports with respect to the farm price of cattle was calculated to be -0.8071. Such a variable might have been included in the present model with a possible improvement in the predictive results. It would not, however, be expected to have an effect on the price spread - export volume relationship which was the centre of interest in this analysis.

In concluding this discussion of the results of the Canadian feeder cattle export analysis, the question of the role and effectiveness of the tariff must be dealt with. It will have been noticed that the tariff has not been included as a separate independent variable in the feeder cattle model. During the period 1970 - 1973, there were only two changes in the American tariff rate on imports of Canadian slaughter cattle. These were the imposition of a 10 percent ad valorem surcharge in August, 1971, and its removal in December of the same year. This provides entirely insufficient grounds for including the tariff as an independent and dynamic factor in the determination of feeder cattle movements. Its inclusion in a regression model could be accomplished by means of a dummy variable, but this would only provide information on the effect of the presence or absence of the tariff, and not on its level. The method followed in these sequences has therefore been to define the price spread variable as including the tariff. As with the analysis of Canadian slaughter cattle imports, the procedure was to subtract the tariff rate from the price spread. The price spread variable was therefore defined as an "effective" spread between the Canadian and American markets. It is the spread which would be expected to actually give rise to a particular volume of trade.

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[1] S.N. Kulshreshtha and A.G. Wilson, "An Open Econometric Model of the Canadian Beef-Cattle Sector," American Journal of Agricultural Economics 54 (February 1972): 84 - 91.

In the analysis of Canadian slaughter cattle imports it was assumed that the estimated relationship between the volume of imports and the price spread was identical to the relationship between the volume of imports and the tariff. Because of the similar definition of the price spread variable in the analysis of Canadian feeder cattle exports (ie. its inclusion of the tariff), the same assumption may be made here. The regression and elasticity coefficients estimated in the feeder cattle export sequences for the price spread variable apply as well to the efect of the

American tariff on Canadian exports of feeder cattle. From thr results of the analyses in Sequences 6 and 7, the following conclusions may be summarized:[1]

Cause	Effect
1. A $1.00 increase in the Kansas City feeder cattle price relative to the average Canadian price.	1. An increase of from 68 to 113 head per week in American imports of Canadian feeder cattle.
2. A 1% increase in the price spread between the Kansas City and Canadian average feeder prices (caused by an increase in the Kansas City price relative to the Canadian price).	2. A 0.15 to 0.23% increase in the weekly volume of American imports of Canadian feeder cattle.

No summary comment will be made regarding the relationship of the volume of Canadian feeder cattle exports and the feeding ratio variable. As mentioned, both the a priori expectation of such a relationship and its statistical demonstration are weak. No conclusive statements ought therefore to be based on the statistical results. Conclusions can, however, be stated with regard to the role of the tariff in the trade of Canadian feeder cattle with the United States. As in the analysis of Canadian imports of slaughter cattle, the regression and elasticity coefficients estimated for the price spread variable apply as well to the elasticity of American imports with respect to changes in the tariff. The calculation of percentage changes in the tariff rate must also, as in the case of slaughter cattle imports, be on the basis of the applicable price spread minus the tariff. Having taken this proviso into account, though, it may be concluded that there is an inelastic (0.15 to 0.23) response of Canadian feeder cattle exports -- or alternatively of American demand for Canadian feeders -- to changes in the price spread cum tariff applying to feeders between the Canadian and American markets.

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[1] Due to the statistical unreliability of the results of the ordinary least squares analysis in Analytical Sequences 6, 7, and 8, they are not taken into consideration here. The Cochrane-Orcutt analyses in sequences 6 and 7 produced coefficient estimates which were slightly different from each other; their summarized results are therefore presented as a range.

Summary

It is often true that an understanding of those factors which are omitted from a study is as relevant as an understanding of those which have been included. It is necessary, therefore, to make some mention of the points which have not been investigated in the present study and may have been notable by their absence.

There has been a less than complete examination of the effect of lags and distributed lag patterns in the independent variables on the explanatory power of the models both for slaughter cattle imports and feeder cattle exports. This has been due to two factors. First, those lags which have been investigated have not appreciably altered the results obtained by utilizing unlagged variables. In the examination of Canadian feeder exports the use of a four week distributed lag had no effect on the R^2, the Durbin-Watson, or the t statistics of the price spread coefficient. In the examination of the technique of analysing monthly averages rather than weekly observations, the expectation might have been that if short term lags in the independent variables were operative and important there would have been an improvement in the predictive power of the models when monthly averages were utilized. The analytical results indicate, however, that this was not the case — the predictive ability of the model appeared to be reduced. The second reason for which further lag patterns were not investigated was that it was impractical to attempt a full survey of their effects. There are an infinite number of possible lags and distributed lag patterns that could be applied to the independent variables. The results which were obtained indicated little effect from such a technique which essentially adds no new economic information to the model. Since the centre of attention for the whole analysis was the relationship between the volume of imports or exports and the price spread cum tariff variable, further pursuit of the matter of lags was decided to be inadvisable.

Another common feature of econometric models which has not been dealt with in the present study is the use of non-linear functions. The primary reason for not attempting to investigate any of these non-linear forms is that they were not employed in any of the studies on which the present analysis was based. The studies of Officer and Hurtubise, Tryfos, and Kulshreshtha and Wilson[1] examined different aspects of the Canadian economy and Canadian-American trade, and in each of them the models were limited to the linear form. While it is not uncommon to extend an econometric analysis to include a curvilinear function, it was not seen as a compelling requirement in the present study.

The examination of Canadian exports of feeder cattle to the United States did not utilize the technique of "tariff blocks" as did the examination of slaughter cattle imports. Two important reasons can be given for this omission. The first is that while this technique at first appears to be an attractive way of isolating the tariff effect on the volume of trade, it is incapable of providing conclusive proof of an effect which might be indicated. It is not possible to isolate the effect of tariff changes from other independent factors operating concurrently. The second reason for not pursuing the tariff blocks technique with feeder cattle export analysis is that there was only one minor change in the United States tariff on imported Canadian feeder cattle within the period under consideration. From August to December, 1971, there was an additional 10 percent surcharge on a range of American imports including Canadian feeder cattle. It was felt that such a change would not provide a sufficient basis for analysing the American tariff by the tariff blocks technique.

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[1] Officer and Hurtubise, "Price Effects"; Tryfos, An Economic Model ; Kulshreshtha and Wilson, "An Open Econometric Model."

The conclusion to this chapter, in which the analytical results of the study have been presented, is a summary and discussion of the findings which relate to the relationship between the tariff and the Canadian-American cattle trade. While the analytical results have not been limited to this relationship, they have constituted the centre of attention for the study as a whole and are an important part of the analytical sequences.

The tariff constitutes what appears to be a fairly surmountable financial obstacle to trade. If the international market is reasonably approximated by a spatial equilibrium model, it would be expected that any price spreads in excess of the tariff plus transportation and transfer costs would induce trade. In the analysis of Canadian imports of slaughter cattle during the period 1970 to 1973, it was seen that the average price spread was 2.36 cents per pound, while the average tariff rate was 1.35

cents per pound. In the case of American imports of Canadian feeder cattle, the average price spread was 2.1 cents per pound, while the average tariff rate was between 1.5 and 2.5 cents per pound. It appears, therefore, that the price spread is normally greater than the barriers presented by the tariff. The price spread minus the tariff is therefore normally a positive amount causing some real volume of trade. The effect of the tariff is therefore to reduce the profitability of trade. In that this reduction of the profitability is a constant amount, the tariff is more influential in periods of a small price spread and low trade volumes than in periods of high price spread and trade volume. It is thus "regressive" in nature and lacks the capability of effectively controlling disruptive commodity influxes.

It would be attractive to be able to make unequivocal statements regarding the relationship of the tariff to such matters as the balance of Canadian-American cattle trade. The conclusions which can be drawn from the present study in this regard are, however, fairly limited. The North American cattle market has recently exhibited notable and rapid changes in its characteristics. These factors make it unwise to draw any forthright conclusions, based on historical data, about the way in which the market will be operating in the future or the role of the tariff in its operation. In the fairly short period between the end of the present study's analysis and the time of writing, there have been substantial and important changes in Canada's trade barriers applying to imported American cattle, and even stiffer retaliatory measures have been adopted against Canadian exports to the United States. These events have undoubtedly altered many of the charcteristics of Canadian-American cattle trade described above.

Notwithstanding these considerations, the results of the analysis in the present study have indicated an elasticity of approximately 1.00 in the response of Canadian imports of American slaughter cattle to tariff and price spread changes, and an elasticity of 0.15 to 0.23 in the response of American imports of Canadian feeder cattle to the tariff and price spread. This would indicate that for given changes in tariff rates there will be a greater response in the volume of Canadian slaughter cattle imports than in the volume of feeder cattle exports. A given bilateral tariff reduction would have greater repercussions in Canada than in the United States in terms of market response to increased import volume. This conclusion, however, must take into account, and in fact could be completely based on, the great disparity in the size of the Canadian and American cattle markets.

The purpose and direction of the analytical sequences in this chapter have been descriptive rather than predictive in nature. The purpose in particular, was to investigate the role of the tariff in Canadian-American cattle trade during the period 1970 to 1973. Econometric models must, however, be validated by comparison of their predicted or estimated results with actual figures. Within the period under observation, this validation is automatically carried out in the estimation procedure, and the R^2 value is presented as the resulting test statistic. Whether the model is or is not used to predict events outside the observational period, the R^2 statistic is an indication of its predictive or explanatory ability. In the case of the sequences in the present study, there was a fairly wide range of R^2 statistics obtained. Those for Sequences 2 and 7 were fairly high (0.92 and 0.72, respectively), leading to the conclusion that these sequences would be acceptable for predictive purposes outside the observational period, if this operation were to be carried out. The one week discrepancy between actual and predicted volumes of trade would have to be taken into account. The alternative would be either to "predict" the previous week's trade volume or to discover a method for removing the discrepancy. Other than this problem, prediction by means of the model would appear to be feasible.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Drawing from the material in the previous chapters of this study, it is possible to summarize the characteristics of the tariff as a trade regulatory instrument. One of the tariff's important features is its effect on income distribution between domestic producers and consumers of the protected product, between domestic producers of the protected product and those of other products, and between domestic and foreign producers of the product. In each case it is the domestic producers of the particular product which are benefited by the imposition of a tariff. Domestic producers of such a product may be benefited not only through the increased domestic price for their product, but also, in an indirect way, through the increased scope of action for domestic policies which favour them. A second beneficiary of tariff imposition is the government, through the collection of tariff revenues. Such income distribution effects are a major consequence of trade restriction through the use of instruments such as the tariff. They may, in fact, be the _raison d'etre_ of such instruments.

The effectiveness of the tariff as a trade regulatory instrument and its ability to provide protection to domestic producers was examined in the present study's econometric analysis. The results of the analysis are strictly applicable only to Canadian-American cattle trade during the period 1970 - 1973. They may, however, be applied to other trade situations and other periods which bear a similarity to the one which was considered.

The statistical analysis of Canadian imports of American slaughter cattle indicated that the elasticity of import volume with respect to the price spread minus the tariff applying between the two countries was unity (1.00). A 1 percent change in the price spread - tariff variable was expected to lead to a 1 percent change in the volume of slaughter cattle imports. In the analysis of American imports of Canadian feeder cattle, the corresponding elasticity was estimated to be in the range of 0.15 to 0.23. The responsiveness of American imports of Canadian feeder cattle to changes in the price spread - tariff is therefore inelastic. Bilateral and equal tariff adjustments, either increments or reductions, would therefore be expected to have a greater influence on the flow of cattle into Canada than on the flow of cattle into the U.S.A.

It is possible, and perhaps preferable, to look at the Canadian-American market from the point of view of a spatial equilibrium model in which the tariff, the exchange rate, and transportation costs are the barriers to trade. In such a case the tariff, transportation costs and the exchange rate will be effective restrictions to trade when the price differential is less than the sum of such restrictions. In such cases, it will no longer be profitable to move units of the product from the lower priced to the higher priced market. Whenever the price spread exceeds the financial barriers to trade, however, product movement from one market to the other will be profitable. From this point of view, the effectiveness of the tariff can only be determined by relating the average tariff to the average price differential, or the tariff and price differential in existence at a particular point in time. This point of view was briefly mentioned in discussing the results of the present study's econometric analysis, and it was noted that the average tariff was less than the average price spread in both slaughter and feeder cattle trade. It appears from the results of the econometric analysis, therefore, that the tariff does not seriously restrict Canadian-American cattle trade during periods of high price differential between the two markets.

Another feature of the Canadian-American cattle market which may be commented on in light of the present analysis is the degree to which the market conforms to the spatial equilibrium model. The volume of Canadian imports of American slaughter cattle displays a price elasticity of

1.00, indicating that there is a fair responsiveness of volume of trade to price spread. The statement might also be made that there was a fair responsiveness of price spread to trade volume demonstrated by the analysis. The French economist, Leon Walras, described the operation of supply and demand in a market in terms of price being dependent on quantity. While this explanation is the reverse of the commonly understood Marshallian description of market operation, it is not inimical to the latter. The two processes are both operative in the exchange relationship. When there is an imbalance between supply and demand in the market, the price of the commodity or service in question will change. The fact and direction of this change are accounted for by Walras. The effect which the price levels and the changes in them have on the quantities supplied and demanded is accounted for by Marshall. The spatial equilibrium model depends as greatly on one explanation as on the other and appears to correspond to the Canadian-American slaughter cattle market fairly well.

The analysis of Canadian exports of feeder cattle to the U.S.A. developed a much lower price spread-cum-tariff elasticity estimate, however, indicating much less responsiveness of trade volume to price spread. Conversely, it may be said that there is a lower responsiveness of price spread to trade volume in the feeder cattle market. Without a more detailed investigation of the day-to-day operation of the market and of the commercial practices and motivations of the firms involved, it would be difficult to say exactly which factors are important in determining the volume of feeder cattle exports to the U.S.A. These unspecified influences on the trade volume must simply be labelled institutional factors. Such factors operate outside the strictly defined spatial equilibrium model and in cases where they are of major importance it could be said that such a model would not apply well.

Spatially dispersed markets are not purely governed by the principles of spatial equilibrium or by institutional factors, but by a combination of both. This is the case in the Canadian-American slaughter cattle market where the spatial equilibrium model applies to a larger extent. It also applies to the feeder cattle market, where the model appears to apply to a lesser degree.

In drawing together the conclusions which may be taken from this study, it is also desirable to make some statement regarding the comparative effectiveness of tariffs and non-tariff barriers. The latter are a type of institutional constraint and it is often claimed that they constitute a more serious impediment to trade than do tariffs. One reason is that NTBs tend to be much more direct in their effect on trade flows than are tariffs. Embargoes and quotas are completely effective in controlling trade. Such

NTBs as health regulations, licensing requirements and various customs classification and valuation procedures are slightly less direct in their effect on trade flows, but may still hamper trade to the extent that it is seriously restricted or eliminated. In contrast to these instruments, tariffs appear to moderate or control trade through a less direct mode of operation. Their influence is exerted on the profitability of trade rather than on the volume of trade itself. This conclusion is borne out by recent events in Candian-American cattle trade regulation. Other than health regulations, Canada has until recently relied on the tariff and occasional tariff surcharges to control imports of American cattle. Following an extremely large and disruptive influx of cattle from the United States in 1973, Canada recently instituted import quotas, similar in nature to those employed by the U.S., to effectively limit the volume of imports during periods when large price differentials make the tariff ineffective. This move to reliance on a non-tariff barrier would appear to indicate the insufficiency of the tariff as a trade policy instrument in periods of abnormal trade flows and price relationships. The American reliance on import quotas in retaliating against these Canadian developments strengthens this conclusion.

There have been complaints from the Canadian cattle industry that the predominant trade flow patterns in the

Canadian-American cattle market are definitely not in Canada's best interest. Canadian feeder cattle have historically been exported to the United States in fairly large numbers while American slaughter cattle have been a major import for Canada. The contention has been that such a trade pattern involves the loss of opportunity for a great deal of value added by Canadian cattle feeders and the loss of accompanying benefit for Canada as a whole.

The implications of tariff and trade policy for this situation depend on the price relationship between the Canadian and American markets. The concepts of an "export floor" and an "import ceiling" are involved in the relationship of prices between the two markets. The export floor is the lowest level to which the domestic price of a commodity can drop relative to the price in another country before exports are triggered. The difference between the foreign price and the domestic export floor is determined by export transportation costs and foreign import restrictions. The import ceiling is the highest level to which the domestic price can rise relative to the price in another country before imports become profitable. Import transportation costs and domestic import restrictions determine the difference between the foreign price and the domestic import ceiling.

Bilateral tariff removal has the effect of narrowing the range between the import ceiling and the export floor, ie., reducing the possible variance of the price in one market relative to that in another. Canadian feeder cattle have traditionally been priced at their export floor while the slaughter cattle price has normally fallen between the two limits or has been at the import ceiling. Tariff removal would therefore be of greater benefit to feeder cattle producers (by raising the export floor price) than to slaughter cattle producers.

The effect of this increase in feeder prices and the possible reduction in slaughter prices would be to reduce feedlot margins, possibly putting many feedlots out of business. Profits in feeding cattle would have to be based more on feeding efficiency than on speculation of a positive feeder - slaughter price margin. Competition between Canadian and American feedlots would also be based more heavily on relative feed costs in the two countries. Tariff removal in the North American market would also have the effect of stabilizing Canadian prices relative to American prices. To the extent that American prices are themselves relatively constant, this would be an absolute stabilization. Tariff removal would also mean, however, that Canada would have less insulation from American agricultural policies. This may not be particularly desirable, in view of developments such as those of the summer and fall of 1973.

Perhaps the most important benefit of tariff removal for the Canadian cattle industry would be that it would force the industry to become more efficient and internationally competitive, even at the expense of a reduction in its size. Such conclusions, drawn from the present analysis, must now, however, be evaluated in light of the developing Canadian-American trade situation and Canadian trade policy.

Recommendations for Further Study

The original objective of this study was to investigate the tariff as a regulatory policy instrument in Canadian-American agricultural trade. It is believed that, to a satisfactory degree, this objective has been met. There are, however, many unanswered questions remaining in the quantitative analysis of Canadian agricultural trade and its relation to Canadian trade policy. One of these unanswered questions deals with the matter of comparative advantage and relative costs of production between Canada and its trade partners.[1] As Canadian agricultural producers realize, their ultimate stance on the question of trade policy must be based on a clear understanding of the competitive cost position of the Canadian agricultural industry relative to that of other countries such as the United States. While this question has not been dealt with in the present study, it is recognized as a vital and closely connected issue.

With regard to further investigation of the tariff as a trade regulatory instrument, a number of questions remain to be answered. The present study has dealt with Canadian-American trade in two types of cattle but attention remains to be given to other agricultural products of importance. Consideration could also be profitably directed to an investigation of other statistical techniques than the ones employed in this study. While the analytical results of the present study appear to be satisfactory, they would profit from comparison with those of other approaches and statistical techniques.

A final recommendation for future investigation is that the concept of effective protection be incorporated into a study on the tariff and agricultural trade. An article by Larry J. Wipf[1] deals with this concept in the context of American agricultural trade, but to this author's knowledge, there is no equivalent Canadian study. Considering the importance of purchased inputs to agriculture, many of which are imported, a study of the effective rate of protection of Canadian agriculture would be a valuable addition to the literature.

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[1] See Gerald I. Trant, "The Impact of Trade Liberalization on Canadian Agriculture," _Trade Liberalization and Canadian Agriculture_. Canada in the Atlantic Economy. (Toronto: University of Toronto Press for the Private Planning Association of Canada, 1968). This important study deals with the matter of comparative advantage. Further examination of the individual commodities could, however, be profitably undertaken.

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[1] Larry J. Wipf, "Tariffs, Non-Tariff Distortions, and Effective Protection in U.S. Agriculture," American Journal of Agricultural Economics 53 (August 1971): 423 - 430.

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APPENDIX 1

FIGURE 3

ANALYTICAL SEQUENCE 1 : COCHRANE ORCUTT ANALYSIS
OF CANADIAN IMPORTS OF AMERICAN SLAUGHTER
CATTLE, WEEKLY OBSERVATIONS, 1970 - 1973

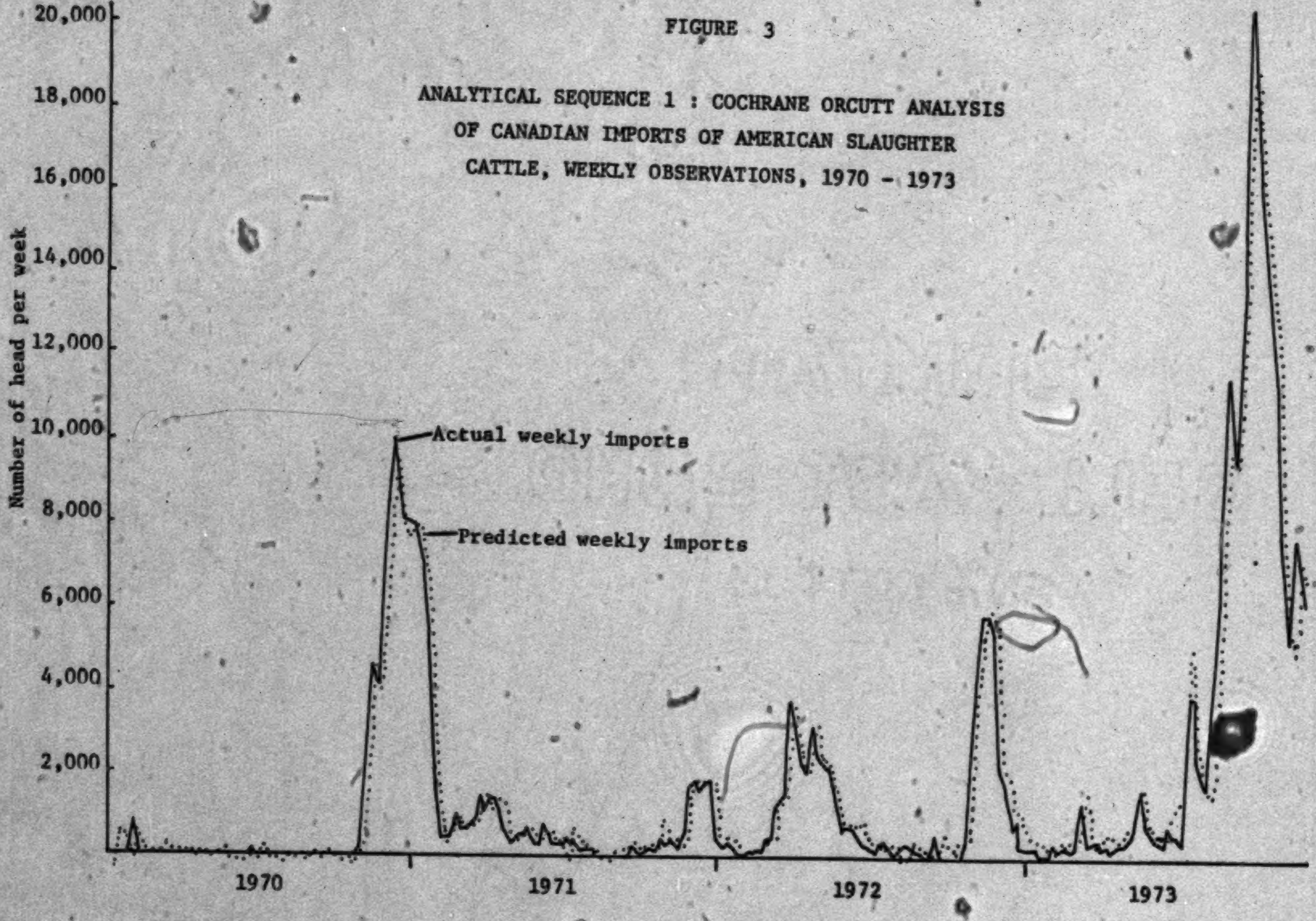
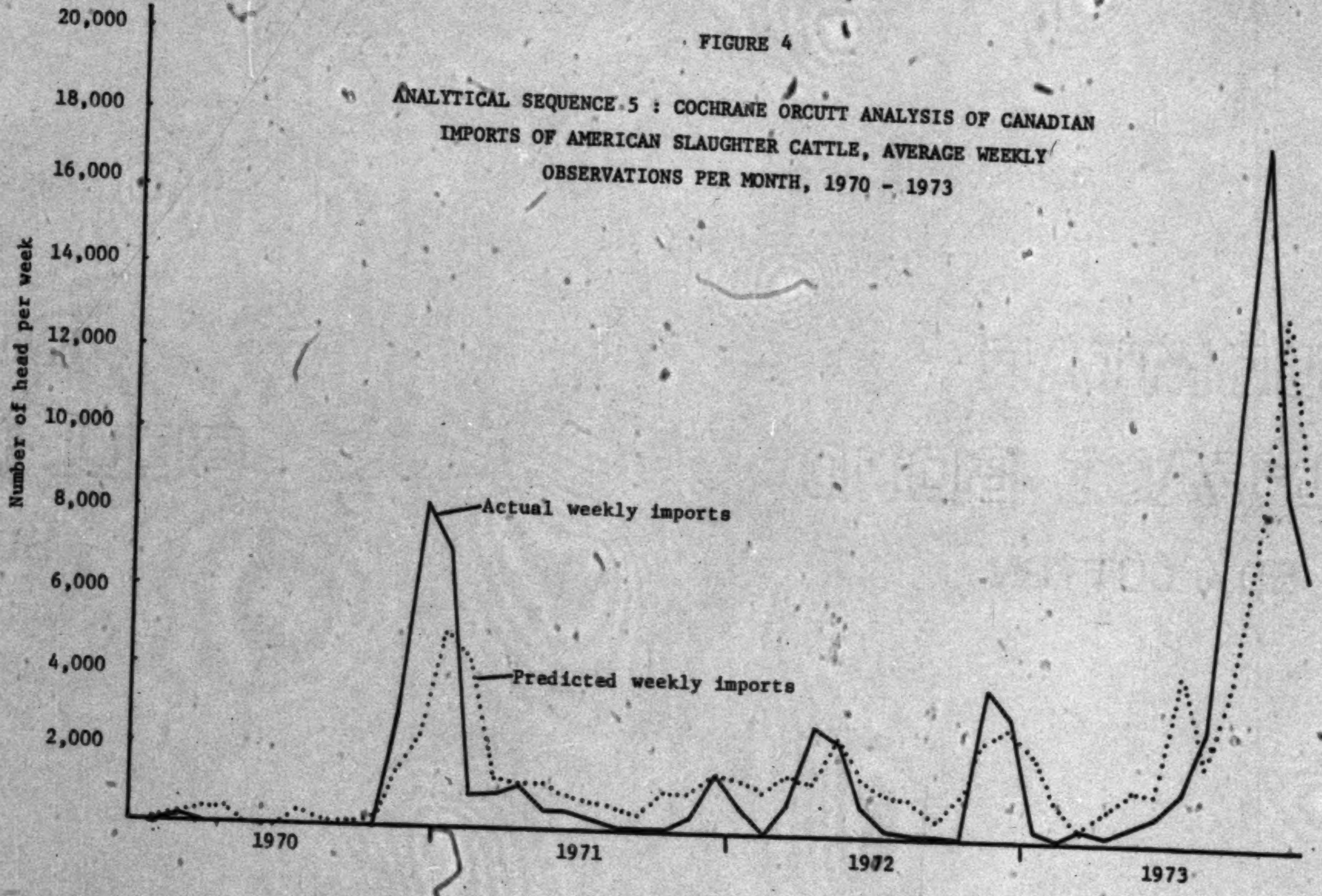


FIGURE 4

ANALYTICAL SEQUENCE 5 : COCHRANE ORCUTT ANALYSIS OF CANADIAN IMPORTS OF AMERICAN SLAUGHTER CATTLE, AVERAGE WEEKLY OBSERVATIONS PER MONTH, 1970 - 1973



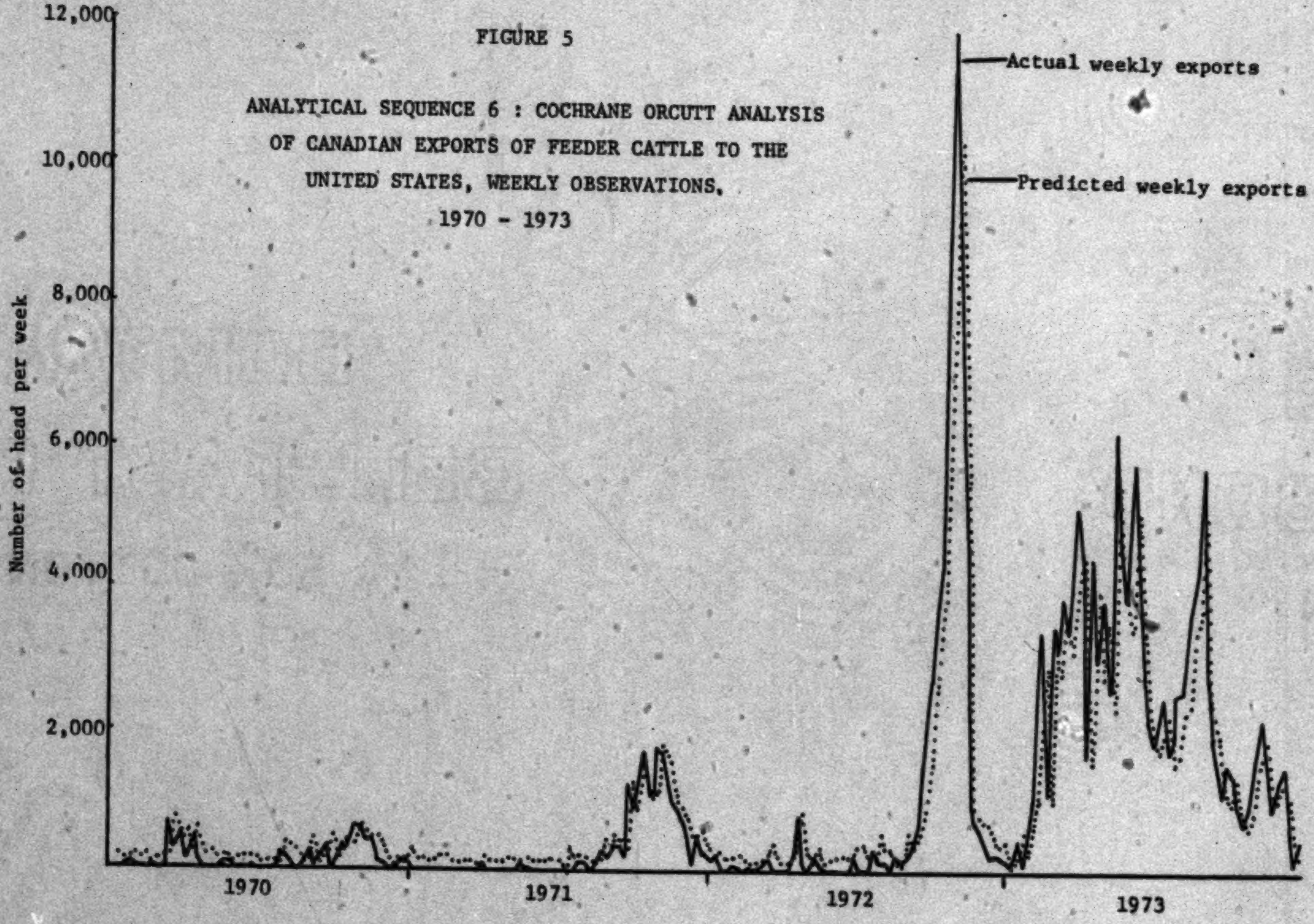
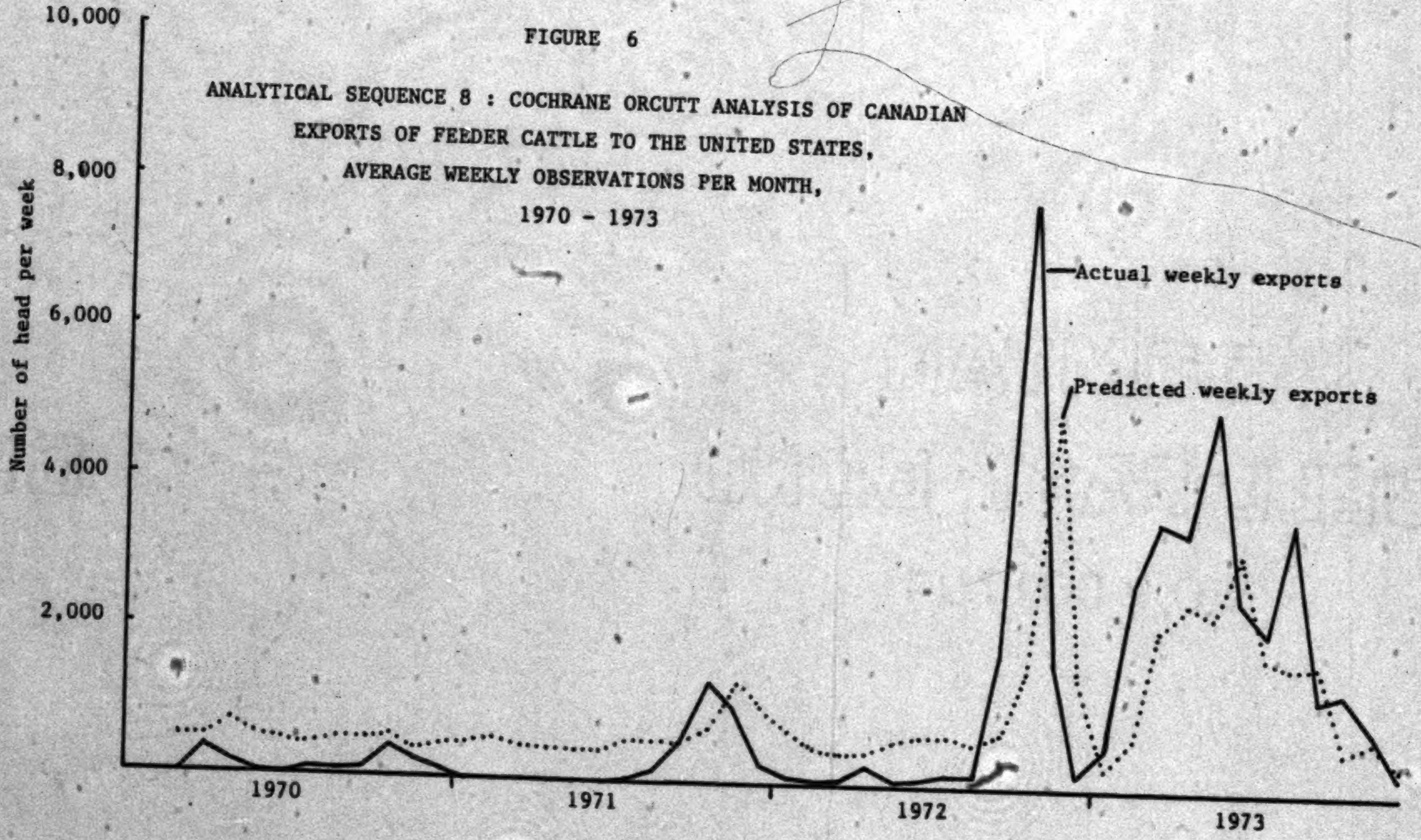


FIGURE 5

ANALYTICAL SEQUENCE 6 : COCHRANE ORCUTT ANALYSIS OF CANADIAN EXPORTS OF FEEDER CATTLE TO THE UNITED STATES, WEEKLY OBSERVATIONS, 1970 - 1973

FIGURE 6

ANALYTICAL SEQUENCE 8 : COCHRANE ORCUTT ANALYSIS OF CANADIAN EXPORTS OF FEEDER CATTLE TO THE UNITED STATES, AVERAGE WEEKLY OBSERVATIONS PER MONTH, 1970 - 1973



APPENDIX 2

Time Series Processor

In carrying out the statistical procedures which were involved in the present study's analysis of Canadian-American cattle trade, a package computer programme, entitled "Time Series Processor", was used. The common abreviation for the programme title, TSP, will be used in this description of its function.

The TSP programme was originally written by R.E. Hall, J. Brode, and F. Ripley for use in the Harvard University Computing Centre. Subsequent adaptations have been made by Steve Hoskins in Computing Services at the University of Alberta.[1] As its name implies, TSP is a computer package or language oriented toward the performance of statistical analyses on econometric problems involving time series, as opposed to cross-sectional data observations. The programme is fundamentally a regression analysis package, incorporating variations on this technique, but is also capable of performing certain matrix operations. It is designed to carry out all the computational steps that occur routinely in econometric research.

A TSP run is composed of one or more independent jobs, each having two basic parts -- the programme section and the data section. While the programme section appears first in the read-in sequence, its first function is to transfer control to the data section. The data section contains commands governing the reading and storage of data arrays or variables which may either be presented in the data section itself or read from an independent data file. TSP statements may occupy more than one card but must be separated from one another by a dollar sign ($). Variables are named as they are read into the storage area, and are later recalled by simply referring to the designated name. When data reading and storage has been completed, a command is encountered at the end of the data section which transfers control back to the programme section.

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[1] Steve Hoskin, ed., "Time Series Processor" (Computing Services Manual, University of Alberta, February 1974).

The function of the programme section is to specify the statistical procedures which are to be performed on the variables presented. By means of a particular statement in the programme section, the user is able to limit the application of a particular procedure to a specified range of observations. Since the data arrays involved are time series observational vectors, this allows a distinction to be drawn between the analyses of various periods of time. This feature is often of particular importance when the investigation involves parameters which undergo periodic alteration. The statement specifying the observational subset under consideration may also appear in the data section, in which it serves to locate the data vector to which it applies. This allows sets of observations from different periods of time to be correctly aligned with one another.

While the TSP programme is capable of a wide range of analytical and computational functions, only those which have been utilized in the present study will be described here. The rubrics under which this discussion proceeds are the commands used to call the particular functions into use.

1. NAME

This command, followed by a name of not more than eight characters, is used to identify the current job. This is the first statement to appear in the programme section.

2. LOAD

This command has two possible functions. Appearing after the NAME statement in the programme section, it causes control to be transferred to the data section so that data may be read. In the data section the LOAD command may also appear, followed in the statement by one or more variable names, causing the data to be read-in under the correct name.

3. SMPL

This is the statement used to describe a subset of observations and consists of the SMPL command and the numbers of the first and last observation in the subset. All the subsequent operations are carried out on this subset until a new SMPL command is encountered. More than one pair of observational numbers may occur in the command, signifying distinct ranges of observations to be considered.

4. GENR

This command allows arithmetic transformations of the data. New variables may be created by performing arithmetic operations on the variables previously loaded or generated. All GENR commands must define a name for the newly created variable, although old variables may be eliminated by using a previously defined variable name. The normal operations of addition, subtraction, multiplication and division as well as leading or lagging variables and finding natural logarithms, exponential functions and absolute values can be accomplished by the GENR command. As many sets of parentheses as are necessary may be used to ensure the correct order of processing.

5. REPL

In the normal mode of operation the TSP programme will set to zero all previous data for a variable if the variable is designated as the output of a procedure. If, for example, the user wishes to redefine a subset of observations within an existing variable, normal programme operation will destroy all previous data for the variable. The REPL command overrides this characteristic, allowing observations outside the defined subset to be maintained while those within the defined space are operated on. The command NOREPL turns off this feature.

6. PRINT

The variables whose names follow this command will be printed subject to the current SMPL definition. The variables specified in this command may be any that are currently defined.

7. CORREL

This command is followed within the same statement by up to fourteen variable names. Its function is to calculate the mean and standard deviation for each variable and the correlation matrix for all the specified variables. In the present analysis this was normally the first statistical procedure to be carried out in any run.

8. OLSQ

This command causes ordinary least squares estimation to be carried out on the variables specified in the statement. These variables must be those which have been previously defined over the current SMPL range, and must be listed with the dependent variable first. The letter "C" must be included in the list of independent variables if a constant term is to be included in the estimation equation. If the "C" is not present, the constant term will be suppressed. The output of the OLSQ procedure includes the following:

1. Statement of the current SMPL range.
2. A list of the names of the variables being dealt with.
3. The mean value of the dependent variable.
4. A table showing, for each independent variable, the estimated regression coefficient, its standard error, its t statistic, and its mean value.
5. The R^2 for the least squares estimation.
6. The Durbin-Watson statistic.
7. The number of observations in the current SMPL range.
8. The standard error of the regression.
9. The variance-covariance matrix for the estimated coefficients.

8. CORC

This command causes least squares estimation and estimation of the first order serial coefficient, rho, to be performed. The method used is the Cochrane-Orcutt iterative technique in which ordinary least squares is used to form an initial guess of rho. The procedure followed in the TSP estimation is the same as was discussed in Chapter 3. Successive iterations are terminated and the output is produced either when rho changes by less than 0.005 from one iteration to the next or when twenty iterations have occurred.

The output from the CORC procedure is the same as that of the OLSQ routine, with a few additions. Between items 3 and 4 as described under OLSQ, there is a list of iterations and the successive values of rho, the final value of rho is presented, and the standard error and t statistic for rho are given.

10. PLOTS

This command operates in conjunction with the regression procedures (such as OLSQ and CORC) and produces a list and graphic plot of the actual and estimated values of the dependent variable, and a list and plot of the residuals. This feature is particularly helpful when the user suspects the presence of autocorrelation and wishes to visually assess the pattern of residuals. The PLOTS feature will operate on all regressions until a NOPLOTS statement is encountered.

11. FORMAT

This command immediately follows a load statement in the data section, and in turn, is immediately followed by the format specifications. Data read in from cards in the data section do not require a format statement since they can simply be presented in the required form. Data to be read from another source requires a format statement and specification. Format statements are written in normal FORTRAN form.

12. STOP

This command informs the TSP programme that there are no more jobs to be read in the programme section. It occurs immediately before the last END statement in the programme section.

13. END

This statement signifies the end of a TSP job within the programme section. If only one job is being run in the programme section, there will be just one END statement following the STOP command. The END statement will also signify the end of the data section.